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The On-Scene Spill Model

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THE ON-SCENE SPILL MODEL

A. OVERVIEW

Dramatic incidences of marine pollution, such as the wreckage of large oil tankers, have highlighted the potential for human caused environmental damage. In attempting to mitigate or avoid future damage to valuable natural resources caused by marine pollution, research has been undertaken by the scientific community to study the processes affecting the fate and distribution of marine pollution, and especially to model and simulate these processes.

One area of research is the computerized Lagrangian transport or trajectory model. Trajectory models attempt to predict the movement of actual or hypothetical pollution spills. Needless to say, all existing computerized trajectory models have their virtues and their defects. It is probably not possible to devise a single computational model or framework to satisfy all users. We have tried to balance the contradictory notion of a comprehensive model that is both easy to use and which rapidly produces useful and accurate results.

Shopping lists for desirable features in an oil spill trajectory model are as varied as the users. Presented below is a biased partial summary of the virtues and defects of our model.

Virtues	Defects
Model is general and applies to trajectory problems.	Model is not specific for a given region or substance.
Model is two-dimensional in space. However vertically isolated layered systems can be modeled.	Model is not three-dimensional in space.
Shorelines (maps) are input data. Model automatically handles either hemisphere and east or west longitude.	A specific shoreline is not built into the model.
User able to generate a shoreline (map) file in less than two hours manually; in less than ten minutes by using micro-computer based digitizing program.	
Shorelines can be optionally coded for geomorphology, environmental sensitivity, political subdivisions or by any other descriptive category or combination of categories the user chooses. Categories can spatially over-lap. Oil distribution can be summarized for any categories coded on map.	

Three maps may be used simultaneously to define the study area or to give detailed view of an area.

Virtues	Defects
Spilled substance modeled as point masses (up to 1000). Parameters assigned to each point mass include: Location (Latitude and Longitude), Release time, Age (for evaporation routines) Pollution type (chosen from eight defaults or user specified), Tide height when beached (if appropriate), Status (evaporated, off map, etc.), plus other model internal parameters.	Spilled substance not treated as blobs with variable volume and thickness.
Evaporation treated as three-component substance with independent half-lives.	Evaporation not treated by more complete theories available.
Spills can be initialized as one-time or continuous spills, at single or multiple sites, in circular distributions or any combination of the above.	
Default parameters available for evaporation routines may be modified interactively.	
Numerical circulation models for input to velocity descriptor routines are available but not part of model.	
Accepts up to twelve velocity fields and six time dependent files which can be assigned or joined to maps and each other in a large variety of combinations.	
Can simulate time dependent velocity fields if (1) fields are slowly varying or (2) if they can be described as a spatial velocity pattern multiplied by a time dependent amplitude file.	Model does not handle real time dependent velocity fields.
Statistical representations of winds and currents can be utilized.	Does not use first-order transition matrices.

Virtues	Defects
Diffusion and spreading treated by stochastic processes.	Gravitational and surface tension effects ignored. Complex representation of sub-grid diffusion and spreading effects ignored. Interaction of spreading and evaporation ignored.
Higher order effects such as beaching and refloating depending on currents, wind, tide height, shoreline geomorphology and other parameters included.	Interaction of spilled substance with sediment and biota ignored.
Users can rapidly build trajectory models without a major investment in man-years for programming and testing of code. Possible to build a complete model including shorelines, currents, winds, spill distribution, and run model in less than four hours.	User required to select large number of parameters or else take defaults. Requires a user sophisticated in oceanography and modeling to run and interpret results.
Almost all model parameters adjustable interactively.	
Checkpoints for partially built models and complete models available.	
Duplicate copies of output saved if desired.	
Large range of coarse graphics available on standard ASCII terminals.	
High quality graphics available on Tektronix terminals and Calcomp devices.	
	Model requires access to CDC Cyber 750/175 for FORTRAN IV version or a virtual memory system for FORTRAN V version. No microcomputer or model subset version available.
Spill response and environmental spill planning receptor models both run from same data initialization.	
All areas modeled have consistent underlying data base structure so user can organize diverse site specific models in a single conceptual framework.	

Virtues	Defects
Model documented and code available. Currently being used in the United States, Australia, and Kuwait by multiple users.	
Model extensively tested and verified. Clear distinction between data base and model is maintained.	

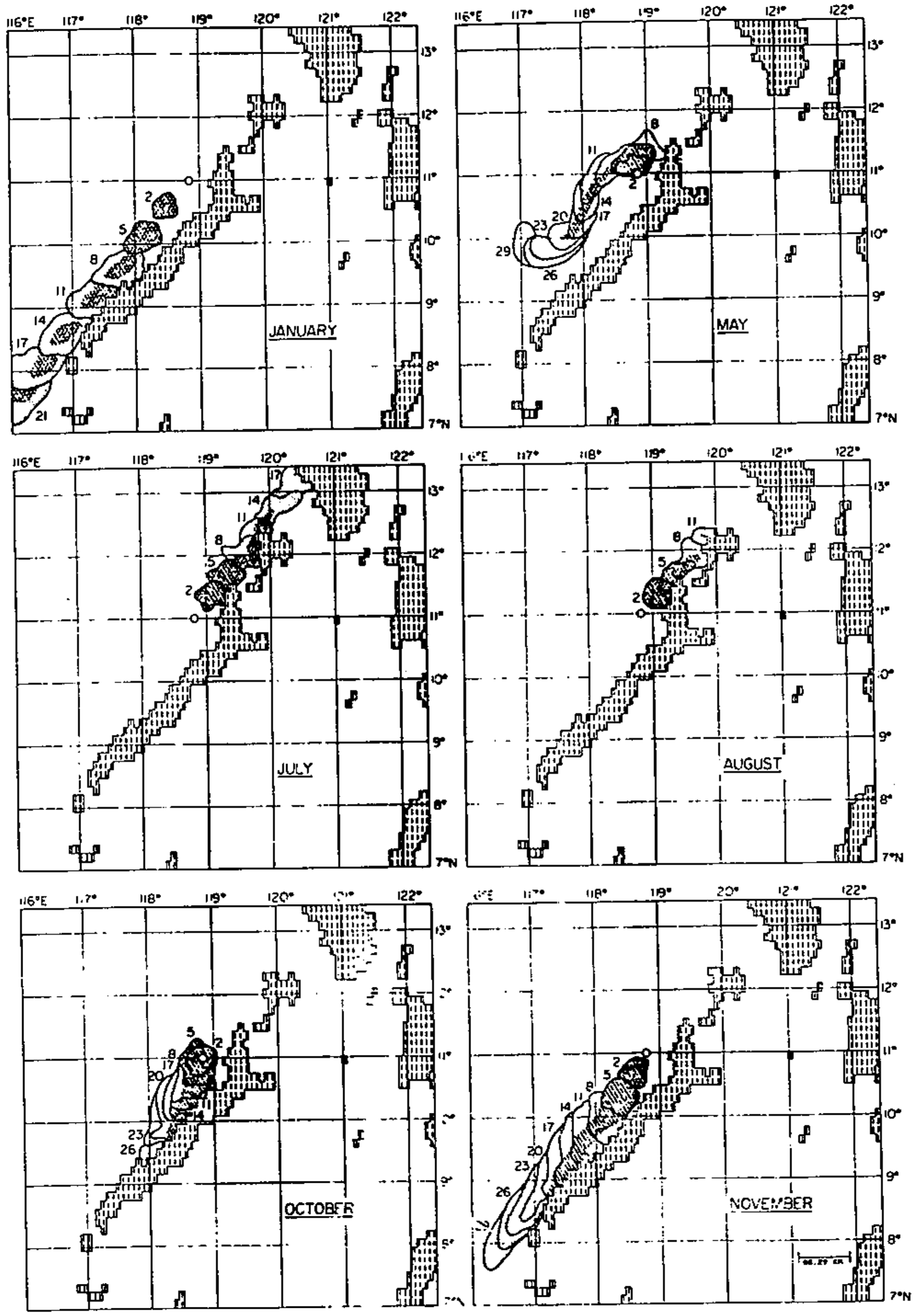
In utilizing a data base management and an integrated software approach to model development, we have attempted to develop a a generalized trajectory model with enough flexibility to satisfy a large number of users without making it overly complex. This is probably more hopeful than actual. It is taken as axiomatic that a model that does everything for everyone will be used by no one, because it will be too difficult to find one's way through the labyrinth of code. The fact that this model is used by researchers other than just ourselves is an encouraging sign that we have produced something of use and value.

INTRODUCTION

The On-Scene Spill Model, Version 9, (OSSM) is an interactive environmental simulation system designed for the rapid modeling of pollutant trajectories in the marine environment. The overall design is that of modular and integrated software. Maps, coastal outlines and shoreline descriptors, bathymetry, numerical circulation models, statistical climatological simulations, location and type of the spilled substance, bathymetry, oceanographic and meteorological observations, and other environmental data are inputs to OSSM. The output from this model consists of both Calcomp and printer graphics, summaries of initialized data, checkpoint files, and copies of the printer graphics stored on magnetic disk for future use. The user can request detailed information about data and model parameters. Additionally, there post-processors for summarizing the output or converting it to a color, animated format which can be viewed with color graphics terminals.

Depending on the data bases used, OSSM can be run in different modes including a climatological mode assessing long-term transport, a strategic mode assessing short-term transport, and receptor modes for environmental or contingency planning. Examples of these three different model uses have been previously described by Torgrimson (1981). The climatological mode uses a climatologically derived data base which typically includes Monte Carlo simulation of regional wind patterns, currents derived from oceanographic atlases, numerical circulation models, and circulation data in the scientific literature. The tactical or short-term assessment mode is designed to provide trajectory results during real-time spill situations. The data base for this type of modeling effort typically includes meteorological predictions for two days and numerical circulation models keyed by direct current measurements and archived tidal current data.

Figure 1. Palawan trajectories showing the effects of seasonality.



The receptor modes pose the reverse problem for a trajectory model. The impact or receptor area is designated. Receptor sites are usually chosen for their perceived economic, biological, or aesthetic value. The receptor modes answer the following four questions:

1.) What is the probability of spills originating in any other region impacting the receptor site?
2.) How long will it take a spill originating in any other region to reach the receptor site?
3.) What percent of a spilled substance will reach the receptor site?
4.) Can the answers to the previous questions be significantly altered by the use of appropriate countermeasures?

OSSM is not constrained to use only data pertaining to a particular spill. It easily handles different environmental simulations or scenarios. The user can vary scenarios and answer questions about a spill that might include:

1.) Under what meteorological conditions can some nearby environmentally or economically sensitive areas be impacted?

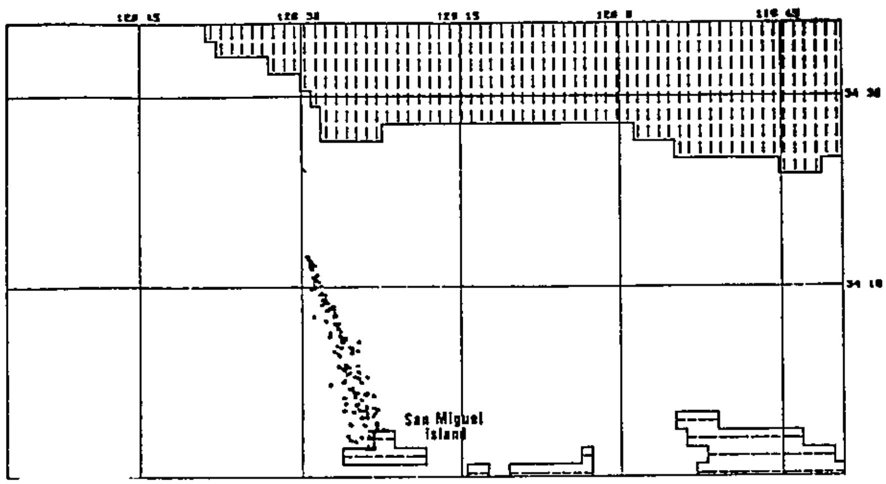
2.) How does the total area impacted depend upon different environmental data, e.g., speed of coastal currents, tidal amplitudes, meteorological forcing, the application of dispersants (Figure 2), etc.?

Any system modeling pollutant transport processes in the marine environment must be able to handle oceanographic and meteorological data ranging over time and space scales that can vary by several orders of magnitude. OSSM allows the user to utilize any time and space scales necessary to resolve the physical transport processes, consistent with the available data. For example, OSSM can simultaneously resolve in coarse detail the surface flow for the entire Gulf of Mexico (quarter degree resolution), resolve in good detail the bathymetrically controlled flow along the Texas shelf (one kilometer resolution), and resolve in fine detail the features of the tidally driven flow in and around the major Texas ports (scale resolution as small as 100 meters or less). OSSM accomplishes this by the use of multiple embedded submodels in the main model.

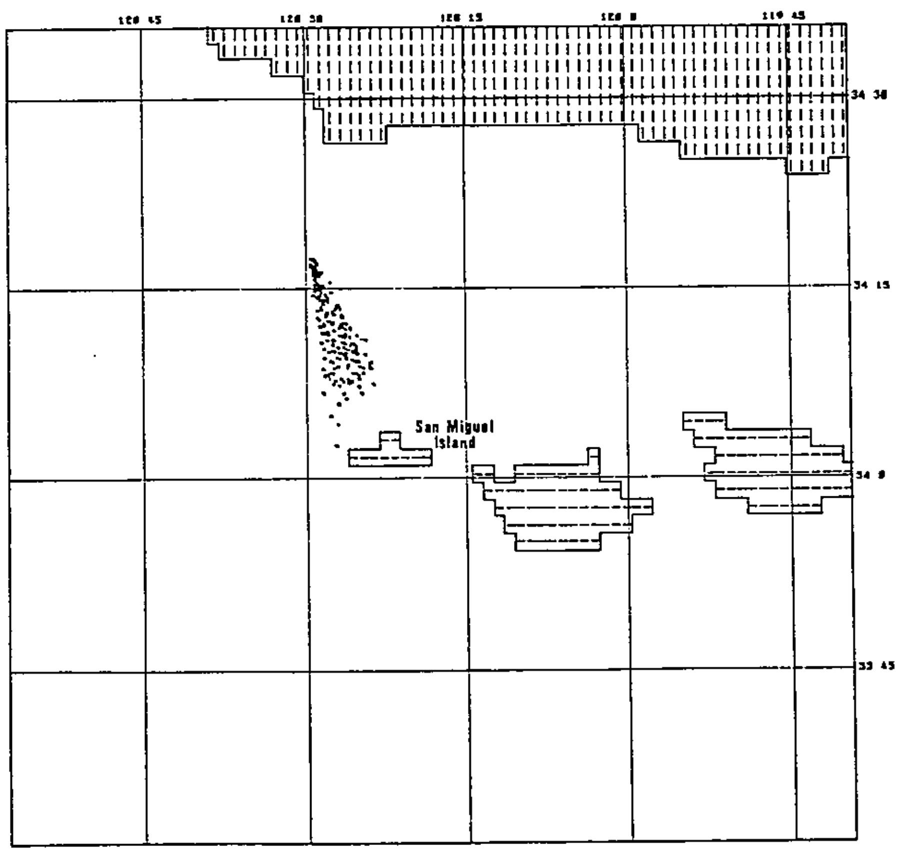
This manual has not been designed for researchers well acquainted with trajectory modeling. It is a user's manual. It is earnestly suggested that the potential user read the entire manual to appreciate the scope and possibilities of the software. Users are free to modify the program in anyway desired. It is suggested also that any changes be noted so that future users will be aware that their version has been modified. An abbreviated list of the commands has been included with manual.

Figure 2. Difference in oil spill trajectories depending on the application of dispersants.

SCENARIO FOR SPILL WITHOUT DISPERSANTS



SCENARIO FOR SPILL USING DISPERSANTS



B. GENERAL EXPLANATIONS

This documentation is written in an outline format that corresponds to the logical construction of the system. OSSM uses a sequence-path response keying strategy. Each section of the system is assigned a sequence of numbers. To shift control to that section, the number is entered. All the subsections of a given section can be branched to in the same way. At any level in the system, detailed instructions and listing of the options or subsections available can be displayed by entering the carriage return (CR).

The following section illustrates the sequence-path response for attempting to delete a non-existent a map file. The user would enter the responses following the question marks (which have been underlined and not indented).

```
     0.0    MAIN OPTION?
? 1(CR)
     0.1.0  INITIALIZE MAPS ------
     0.1.0  INITIALIZE MAP OPTION?
? 2(CR)
     0.1.2  ENTER MAP FILE NAME, A7 FORMAT
? (CR)
     0.1.2  NECESSARY TO IDENTIFY MAP FILE TO SET ANY INITIALIZATION
            PARAMETERS
     0.1.2  ENTER MAP FILE NAME, A7 FORMAT
?   NOFILE(CR)
     0.1.2  MAP FILE NAME NOFILE NOT RECOGNIZED
            DO OPTION 0.1.1
     0.1.2  ROUTINE BYPASSED
     0.1.0  INITIALIZE MAP OPTION?
? 99(CR)
     0.0    MAIN OPTION?
? 999(CR)
     END-OF-JOB
```

In the above section the user attempted to delete a file named NOFILE, which had not yet been initialized.

C. CAVEATS:

Quite often, it is inquired if a trajectory model is accurate, adequate, or correct. Trajectory models should always be correct--this is a direct function of the coding of their algorithms. The accuracy and adequacy of a model are more often associated with the data bases used for the calculations and the physical processes modeled. Only by clearly separating the data bases from the model can the questions of accuracy and adequacy be clearly addressed.

OSSM can be used with virtually any data base. It is the user's responsibility to determine the accuracy and adequacy of any proposed data base that might be used. Because of the ease with which OSSM can handle many data bases, OSSM allows the user to compare data bases and explicitly show the various results from different data bases in the same format.

The author would appreciate any operational errors in OSSM being brought to his attention.

C.1 UNITS:

All current and wind data are assumed to be in units of meters/second. All tidal elevation data is assumed to be in meters. Realizing that data are often available in a variety of units, the user can scale the data through the use of multiplicative factors. A set of conversion factors for data in various units can be found in Table 1.

C.2 LOCATION:

Latitude and longitude for locations are always entered as integer degrees and real minutes. For example, 123 degrees, 13 minutes and 20 seconds would be entered as "123,13.33".

C.3 TIME:

Time for keying measurements and and the model is usually entered as DAY,MONTH,YEAR,HOUR,MINUTES, where each entry is only two digits. Year uses the last two digits of the year.

TABLE 1. Conversion factors for scaling data.

DATA TYPE	UNITS	MULTIPLICATIVE FACTOR
CURRENTS	m/s	1.0
	cm/s	0.01
	knots	0.5144
	miles/hour	0.4470
WINDS*	m/s	0.03
	cm/s	0.03*0.01 = .0003
	knots	0.03*0.5144 = .015432
	miles/hour	0.03*0.4470 = .013410
TIDAL ELEVATION	meters	1.0
	feet	0.3048

(*assumes a wind driven surface velocity equal to three percent of the wind speed).

D. DATA FILE FORMATS:

OSSM uses several files for inputing and storing different types of data. In practice, the user is always able to write a short program to reformat their data bases for use in OSSM. The creation of the standard map files containing coastlines and shoreline descriptors as well as standardized numerical models for OSSM has been simplified by procedures implemented on a personal computer and described elsewhere. Every file type and format used by OSSM is referenced by the sequence-path response code that utilizes it. They are listed in Table 2.

A detailed explanation of these particular files, their data, data formats, and customary usage follows.

MAP FILES AND OPTIONAL SHORELINE DESCRIPTORS

OSSM uses a square grid (48 lines of 80 columns) containing 80 boxes in the east-west direction and 48 boxes in the north-south direction to digitize all maps (Figure 3). An 80 horizontal by 48 vertical grid can be printed on most hard copy terminals as an eight inch square block. The actual digitizing can be done either manually with mylar grids which come in a range of sizes, from six inches to 36 inches on a side, or with microcomputer aid digitization techniques. A range of sizes allows the user to work with maps of varying scales and to choose the appropriate scale of resolution. Map photo reduction techniques can further aid this process.

Maps can be described in terms of map lines in an east-west direction containing segments of either land or water. Any map line can be described with two basic codes, one for land and one for water. This is the simplest type of map to code. For any given line of the map, the user counts the number of boxes of land and water on that particular line. Hence, if we had a map with a north-south running coastline on the eastern side and we allowed the water areas to occupy seven-eighths of the map, all lines of the map would contain only two segments and would be coded as:

70WW10LL.

The land and water descriptors are two character codes. For the simplest type of maps only "WW" for water and "LL" for land are used. The number which precedes them is always two digits, and indicates how many contiguous columns on that particular line of the map are water or land. Each of the 48 map lines would be coded as a separate file line. A maximum of twenty segments can be coded on a given file line. If a map line requires more than twenty segments to describe it, additional file lines are used. Figure 4 shows a map for the Washington coast and Figure 5 shows its coded version.

A map grid box that contains more water than land would usually be designated as water. In general, gridding a map is not a totally objective process and is subject to the judgment of the user. The user may elect to code a narrow channel to preserve the channel flow.

TABLE 2. Files used by OSSM.

MAP FILES AND OPTIONAL SHORELINE DESCRIPTORS
0.1.1 LOAD MAP FILE AND OPTIONAL SHORELINE DESCRIPTORS
0.1.7 DUMP MAP TO DISK

LAGRANGIAN ELEMENT FILES
0.2.5 INITIALIZE FROM DISK FILE
0.2.6 WRITE TO DISK FILE

WIND/CURRENT/SURFACE ELEVATION FILES
Grid Files
Streamfunction Grid Files
0.3.2 GET/LOAD STREAMFUNCTION GRID
0.3.9 DUMP A GRID TO DISK
Latitude-longitude/vector Files
0.3.3 GET LAT/LONG VELOCITY FILE--LOAD GRID
0.3.9 DUMP A GRID TO DISK
0.10.33 READ/PLOT LAT/LONG VELOCITY FILE
Time-dependent Files
0.3.22 GET/LOAD TIME FILE
0.3.25 DUMP A TIME FILE AREA TO DISK

WIND HISTOGRAM FILES
0.5.2 LOAD A WIND HISTOGRAM

USER DEFINED AND FORMATTED FILES
0.6.n User written routines

INITIALIZATION FILES
0.8.2 READ INITIALIZATION FILE FROM DISK
0.8.3 WRITE INITIALIZATION FILE TO DISK

DIAGNOSTIC ANALYSIS OF CURRENTS (DAC) AND STREAMFUNCTION ANALYSIS OF CURRENTS (SAC) FILES
Vertex and Boundary Data Files
0.10.41 GET VERTEX AND BOUNDARY DATA
Triangle Data Files
0.10.42 GET TRIANGLE DATA
Streamfunction Data Files
0.10.43 GET STREAMFUNCTION DATA

DATA FROM FIELD SAMPLING PROGRAMS FILES
Wind and Current Measurements Files
0.3.11 FIT MEASURED CURRENTS WITH GRIDS (LEAST SQUARES)
Other Field Sampling Data Files
0.11.1 SELECT SPILL-ACQUIRED-DATA FILE.

Figure 3. The OSSM grid.

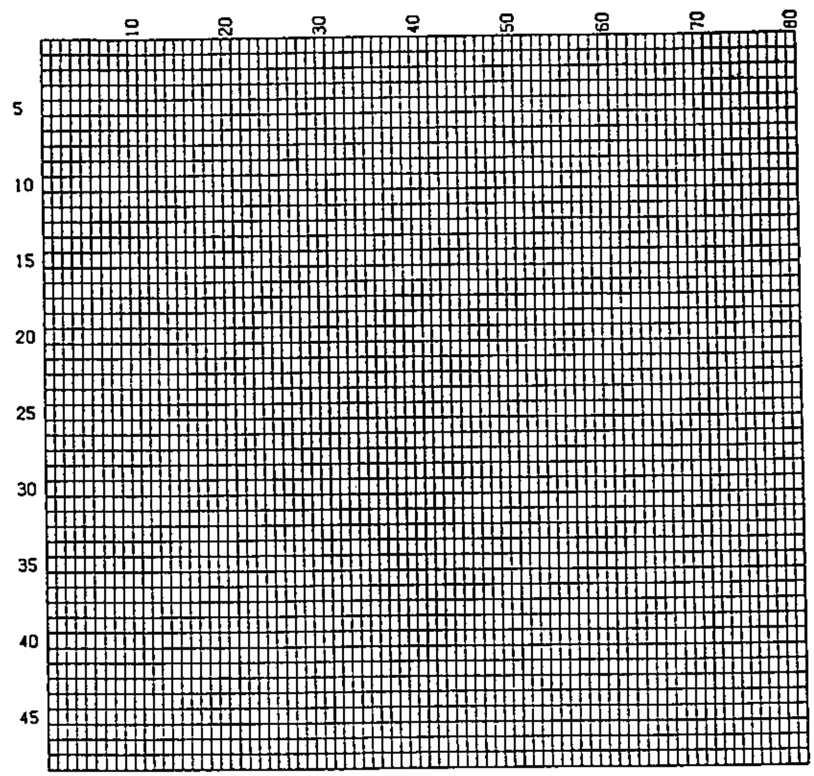


Figure 4. Map of the Florida coast.

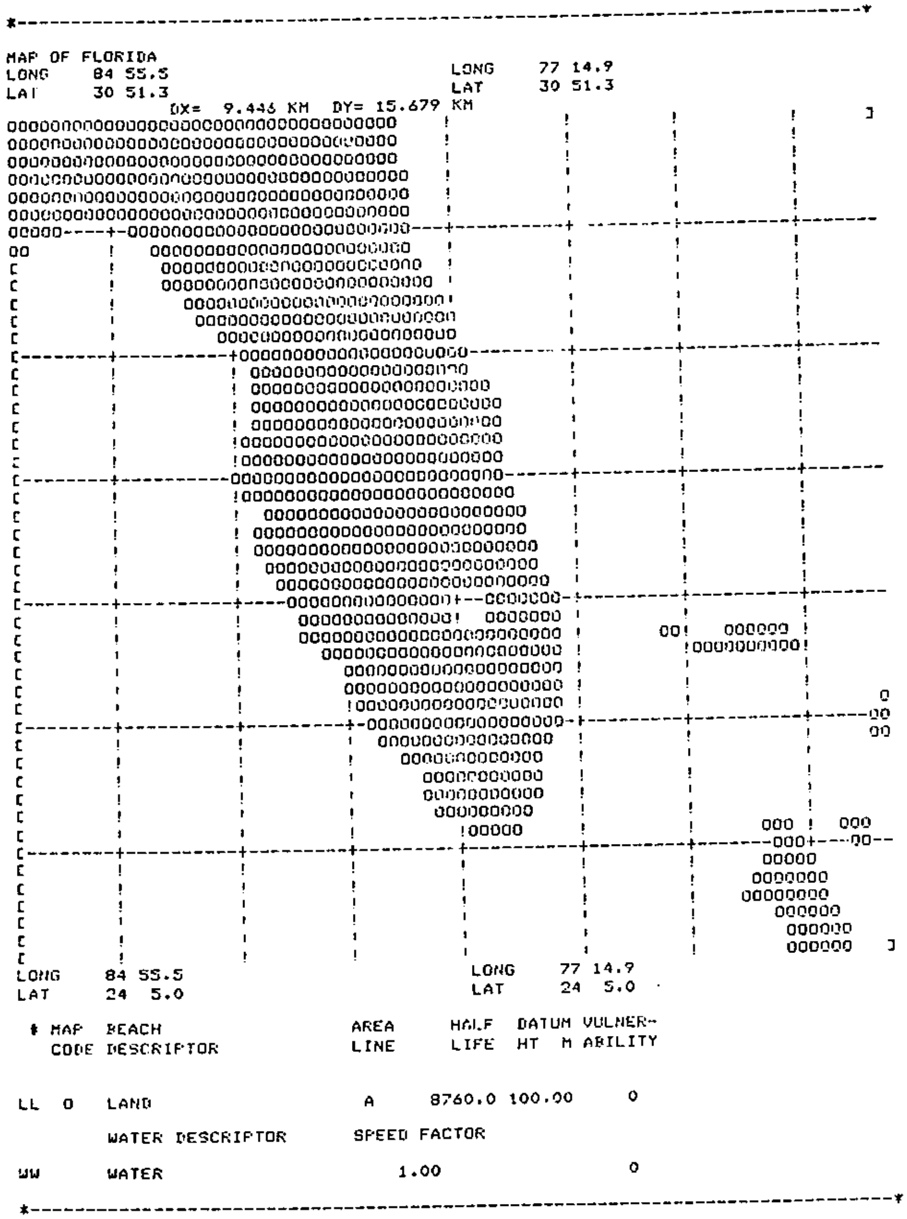


Figure 5. Code for previous figure.

```
MAP OF FLORIDA
3Ø,51.3,24,5,84,55.5,77,14.9
36LL44WW
36LL44WW
36LL44WW
37LL43WW
37LL43WW
37LL43WW
Ø5LLØ6WW26LL43WW
Ø2LL11WW24LL43WW
14WW24LL42WW
14WW25LL41WW
16WW24LL4ØWW
17WW24LL39WW
19WW22LL39WW
21WW21LL38WW
22WW2ØLL38WW
22WW22LL36WW
22WW23LL35WW
22WW23LL35WW
21WW24LL35WW
21WW24LL35WW
2ØWW25LL35WW
21WW25LL34WW
23WW24LL33WW
22WW25LL33WW
22WW26LL32WW
23WW25LL32WW
24WW25LL31WW
25WW15LLØ3WWØ7LL3ØWW
26WW14LLØ3WWØ7LL3ØWW
26WW24LLØ9WWØ2LLØ4WWØ6LLØ9WW
28WW22LL12WW1ØLLØ8WW
3ØWW2ØLL3ØWW
3ØWW2ØLL3ØWW
31WW19LL29WWØ1LL
32WW18LL28WWØ2LL
33WW16LL29WWØ2LL
25WW13LL32WW
37WW11LL32WW
37WW11LL32WW
38WWØ9LL33WW
41WWØ5LL22WWØ3LLØ4WWØ3LLØ2WW
69WWØ3LLØ4WWØ2LLØ2WW
68WWØ5LLØ7WW
67WWØ7LLØ6WW
66WWØ8LLØ6WW
69WWØ6LLØ5WW
7ØWWØ6LLØ4WW
7ØWWØ6LLØ4WW

-END OF FILE-
```

However, using an embedded and enlarged map (multiple models) might be a better idea. Obviously, the user is limited by the size of the OSSM grid boxes in resolving any given map. A more complex description of the shoreline for any area can be coded using additional map codes. Each map code has a set of default parameters. The map codes and their associated default parameters are listed in Tables 3a and 3b.

Codes L0 through L9 would be used in place of code LL to describe the shorelines of the model map area. Codes W0 through W3 are reserved for areas that can be periodically inundated by changes in sea level. These would include tidal flats, marshes, mangroves, and sand bars.

Explanation of the default parameters for shorelines:

The default parameters contain information pertaining to physical processes. "Areal or lineal" is a descriptive parameter to indicate whether the shoreline feature is appropriately described in terms of area or length. This parameter is available so that impacts of pollutants can be described in terms of either area units or length units.

"Half life" is a parameter which empirically describes the adhesiveness of the oil to the shoreline. It is a function of substrate porosity, the presence or absence of vegetation, the inherent stickyness of the oil, and other physical properties and processes of the environment as well. These different parameters have been lumped together in a single parameter, "half-life". This is the number of hours in which half the oil on a given shoreline is expected to be removed if there is an offshore wind or diffusive transport and sea level is at the same level or higher than the level of the oil when it was beached. This parameter, along with the other environmental data, allows refloating of oil after it has impacted a given shoreline.

"Datum height" is the maximum height above mean sea level at which oil can be deposited. For convenience it is usually taken to be 100 meters, regardless of the actual beach topography. The only place where the user would use a different value would be for sand bars, mangroves, tidal flats, or other areas which can be completely inundated during part of the tidal cycle (daily, fortnightly, or neap).

"Vulnerability" is the vulnerability index of the shoreline (Gundlach and Hayes, 1978; Hayes et al., 1980). It is a measure of environmental sensitivity which includes the sensitivity of the biota to an oil spill, the available environmental energy to naturally clean the area, the long term persistence of oil in this environment, the difficulty of cleaning the area through human intervention, and other factors. These factors are intrinsically related to each other. A low value indicates an area with a low vulnerability to an oil spill. High values (maximum is 10) indicate the most sensitive areas. "Vulnerability" allows the model to summarize potential and actual impacts of spilled pollutants by the sensitivity of the environment.

TABLE 3a. Shoreline descriptor default parameters.

MAP CODE LAND	SHORELINE DESCRIPTOR	AREAL LINEAL	HALF LIFE (HRS)	DATUM HEIGHT (METERS)	VULNER-ABILITY INDEX
L0	EXPOSED HEADLAND	L	1	100.	1
L1	WAVE-CUT PLATFORM	L	1	100.	2
L2	POCKET BEACH	L	24	100.	3
L3	SAND BEACH	L	24	100.	4
L4	SAND AND GRAVEL BEACH	L	24	100	5
L5	SAND AND COBBLE BEACH	L	8760	100.	6
L6	EXPOSED TIDE FLATS	A	1	0.	7
L7	SHELTERED ROCK SHORE	L	8760	100.	8
L8	SHELTERED TIDE FLAT	A	8760	0.	9
L9	SHELTERED MARSH	A	8760	0.	10
LL	LAND	A	8760	100.	0

TABLE 3b. Water descriptors and their default parameters

MAP CODE WATER	WATER DESCRIPTOR	CROSS- OR SELF-REFERENCE TO MAP CODES	SPEED FACTOR	VULNER-ABILITY INDEX
W0	EXPOSED TIDE FLATS	(references L6)	0.30	7
W1	SHELTERED MARSH	(references L9)	0.30	10
W2	WATER	(references W2)	1.00	0
W3	WATER	(references W3)	1.00	0
WW	WATER	(references WW)	1.00	0.

TABLE 3c. Cross- and self-reference codes.

	LAND CODES											WATER CODES				
TWO DIGIT CODE	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
REFERENCES	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9	LL	W0	W1	W2	W3	WW

Water areas adjacent to shorelines have been subdivided into five categories. Water descriptors can cross-reference shoreline descriptors. This is done for areas that can be inundated periodically--they are described both as shoreline types and submergible areas. The last three water types have not been pre-assigned cross-references.

"Speed factor" is an empirical measure of the reduced or enhanced energetics of these environments when submerged. The speed factor modifies the numerical velocities calculated for these areas. The numerical velocities are a combination of currents, differential drag, and Stokes' drift due to wind, diffusion and other processes.

The water areas have a vulnerability based on the shoreline descriptors which they cross-reference. If they do not cross-reference shoreline descriptors, they can have an independent vulnerability index assigned to them which would most likely be a measure of the sensitivity of a particular region based on endemic species.

All shoreline and water descriptor parameters can be changed by the user without modifying the program. This is accomplished by including the optional shoreline descriptor lines at the end of the map file.

Because of the generality of the shoreline descriptors, they have other uses as well. Figures 6 and 7 show the use of shoreline descriptors to delineate the different countries bordering the coastline of the Arabian Gulf. All associated default parameters have been set to be the same as "LL", the usual shoreline parameters for most trajectory models. However, the shoreline descriptors have been changed to the names of the countries. In this manner all oil impacts will be summarized by country. <u>The use of the shoreline parameters allows the user to divide a map's coastlines by any useful operational nomenclature: geophysical; political; geographical; etc.; and to have the presence of oil summarized by these categories</u>. Additionally, offshore areas can also be described by the same techniques because water codes are also available. <u>For example, it is possible to summarize all oil within 50 kilometers of a given area, all oil within fixed bounding latitudes and longitudes, all oil within any regularly or irregularly shaped areas that need not be contiguous, etc</u>. OSSM allows for 16 summary categories for each map. The use of multiple models in OSSM allows for a total of 48 separate summary categories for a given area. The same map can be utilized with a lower priority to provide the summary information, and summary categories can overlap since they can be designated for each load of a map. It is possible to simultaneously code and summarize the geomorphological shoreline descriptors for one map, the political descriptors for the second loading of the map, and the geographical descriptors for the third loading of the map.

Figure 6. Map for Arabian Gulf using shoreline descriptors to delineate each country's coastline.

```
*--------------------------------------------------------------------------*

ARABIAN GULF AND SURROUNDING COUNTRIES
LONG     47 46.2                                 LONG     56 12.7
LAT      30 16.1                                 LAT      30 16.1
               DX= 10.474 KM  DY= 17.570 KM
BAAAAAAAGGGG   GGGG !GGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OBBBBAAAG--+--------+GGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
BBBBBB     !        ! GGGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
BBBBBB     !        !  GGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
BB!        !        !   GGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
BBB        !        !    GGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
BBBB       !        !    GGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
BBBB       !        !     GGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OBBBB------+--------+-----GGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOBBB     !        !       GGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOBBB    !        !        !GGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOCC    !        !        ! GOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOCC   !        !        ! GGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOC   !        !        !  GGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOCCC-+--------+--------+--GGGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOCC!        !        !    GGGGGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOCC!        !        !        ! GGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOCCCCC      !        !        !   GGGGOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOCCC     !        !        !    GGGGOOOOOOOOOOOOOOOOOOOOOOOOGGGGG
OOOOOOOOOOOOOOOCC   !        !        !       GGGGGOOOOOOOOOOOOOOOOOOOOGGGGG
OOOOOOOOOOOOOOOCCC--+--------+--------+--------+-GGGGOOOOOOOOOOOOOOOOGGG-+--
OOOOOOOOOOOOOOOCCCC !        !        !        !   GGGGGGGOOOOOOOGGGGG GGGGG
OOOOOOOOOOOOOOOOOCCCC        !        !        !        !GGGGGOGGGG GGGG !
OOOOOOOOOOOOOOOOOCCC         !        !        !        !   GGGGG!  G    !
OOOOOOOOOOOOOOOOOOCCCC       !        !        !        !        !       !
OOOOOOOOOOOOOOOOOOOCCC  EE   !        !        !        !        !       !
OOOOOOOOOOOOOOOOOOOOC+C-EE---+DDD-----+--------+--------+--------+-------+FF
OOOOOOOOOOOOOOOOOOOCC   EE   DDDDDD   !        !        !        !       !FF
OOOOOOOOOOOOOOOOOOOOCC      DDOOODD   !        !        !        !       FFF
OOOOOOOOOOOOOOOOOOOOOC     DDOOOODD   !        !        !        !    FFFFFO
OOOOOOOOOOOOOOOOOOOOOOCC   DDDOOODD   !        !        !        !   FFFFOOO
OOOOOOOOOOOOOOOOOOOOOOOCC  DDOOOODD   !        !        !        ! FFFFFOOOO
OOOOOOOOOOOOOOOOOOOOOOOOC  DDOOOODDD  !        !        !        ! FFFFOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOCC-DDDOOODD---+--------+--------+--------FFFFOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOCCOOOOODD   !        !        !      FFFFOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOCCOOODD     !        !        !    FFFFOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOF     !        !        !  FFFOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOFF FF !        !        ! FFFOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOFF !        !       FFFFOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOF-+--FFFFFFFFFFFFFFFFOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOFFFFFFOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
LONG     47 46.2                                 LONG     56 12.7
LAT      22 40.8                                 LAT      22 40.8
```

# MAP CODE		BEACH DESCRIPTOR	AREA LINE	HALF LIFE	DATUM HT M	VULNER-ABILITY
L0	A	IRAQ	L	8760.0	100.00	0
L1	B	KUWAIT	L	8760.0	100.00	0
L2	C	SAUDI ARABIA	L	8760.0	100.00	0
L3	D	AL QATAR	L	8760.0	100.00	0
L4	E	BAHRAIN	L	8760.0	100.00	0
L5	F	U. A. E.	L	8760.0	100.00	0
L6	G	IRAN	L	8760.0	100.00	0
LL	O	NON-COASTAL AREAS	A	8760.0	100.00	0

	WATER DESCRIPTOR	SPEED FACTOR	
WW	WATER	1.00	0

Figure 7. The code for previous figure.

```
ARABIAN GULF AND SURROUNDING COUNTRIES
 30. 16.0999998 22. 40.8 47. 46.2 56. 12.70000020001
 1L1 7L0 4L6 4WW 4L6 2WW 2L656LL
 1LL 4L1 3L0 1L613WW 3L655LL
 6L117WW 4L653LL
 6L119WW 3L652LL
 2L124WW 2L652LL
 3L124WW 2L651LL
 4L123WW 2L651LL
 4L124WW 2L650LL
 1LL 4L123WW 3L649LL
 3LL 3L124WW 2L648LL
 4LL 3L124WW 2L647LL
 5LL 2L225WW 1L647LL
 6LL 2L224WW 3L645LL
 7LL 1L225WW 3L644LL
 7LL 3L223WW 4L643LL
 9LL 2L225WW 7L637LL
 9LL 2L231WW 3L635LL
 9LL 5L230WW 4L632LL
12LL 3L230WW 4L626LL 5L6
15LL 2L231WW 5L622LL 5L6
15LL 3L233WW 5L617LL 3L6 4WW
16LL 4L234WW 8L6 7LL 5L6 1WW 5L6
18LL 4L238WW 5L6 1LL 4L6 2WW 4L6 4WW
19LL 3L241WW 5L6 3WW 1L6 8WW
19LL 4L257WW
20LL 3L2 2WW 2L453WW
20LL 1L2 1WW 1L2 2WW 2L4 4WW 3L344WW 2L5
20LL 2L2 3WW 2L4 3WW 6L342WW 2L5
21LL 2L2 6WW 2L3 3LL 2L341WW 3L5
22LL 1L2 5WW 2L3 4LL 2L330WW 5L5 1LL
23LL 2L2 3WW 3L3 3LL 2L337WW 4L5 3LL
24LL 2L2 2WW 2L3 4LL 2L335WW 5L5 4LL
25LL 1L2 2WW 2L3 4LL 3L333WW 4L5 6LL
25LL 2L2 1WW 3L3 3LL 2L332WW 4L5 8LL
27LL 2L2 5LL 2L330WW 4L510LL
27LL 2L2 3LL 3L329WW 4L512LL
33LL 1L529WW 3L514LL
33LL 2L5 1WW 2L523WW 3L516LL
36LL 2L520WW 4L518LL
37LL 1L5 5WW17L520LL
37LL 7L536LL
80LL
80LL
80LL
80LL
80LL
80LL
80LL

L0   100.00  1   0 8760.00 IRAQ
L1   100.00  1   0 8760.00 KUWAIT
L2   100.00  1   0 8760.00 SAUDI ARABIA
L3   100.00  1   0 8760.00 AL QATAR
L4   100.00  1   0 8760.00 BAHRAIN
L5   100.00  1   0 8760.00 U. A. E.
L6   100.00  1   0 8760.00 IRAN
LL   100.00  2   0 8760.00 NON-COASTAL AREAS
WW     1.00 16   0

 EOI ENCOUNTERED.
```

ACTUAL CODING OF A MAP FILE

LINE	DATA ITEMS	FORTRAN FORMAT
First	Map Title	8A10
Second	Upper Latitude, Lower Latitude, Left Longitude, Right Longitude (see section C.2)	Free Format
Third to 50	(Number of Columns, Map Code Descriptor)	20(I2,A2)
50+n	Additional lines if necessary for full map	
50+n+1	Blank Line	
50+n+2	Blank Line	

The file always contains two blank lines at the end. If the optional shoreline descriptors are to be modified, data lines for them are inserted between the two blank lines. If the user reads in a map file to OSSM and then dumps it back to disk, OSSM will automatically add the default shoreline descriptors in use for this file. It is usually easier to modify them this way than to code them directly. Their format is as follows:

LINE	DATA ITEMS		FORMAT
After first blank line	Shoreline descriptor code	or Water descriptor code	A2,1X,
	Datum Height	Speed Factor	F7.2,1X,
	Areal/lineal	Cross-reference	I2,1X,
	Vulnerability	Vulnerability	I2,
	Half-life		F7.2,1X,
	Beach descriptor		2A10

The shoreline descriptor code is the previously defined land map code, L0 through L9, and LL. Areal/lineal is coded 1 for area and 2 for linear. Datum height, vulnerability, half-life, and beach descriptor can be given any appropriate value, and the default value for only this map will be changed. A negative entry for vulnerability will cause information about that shoreline descriptor to be suppressed.

The water descriptor code is the previously defined water map code, W0 through W3, and WW. Speed factor and vulnerability can be given any appropriate value, and the default value for only this map will be changed. A negative entry for vulnerability will cause information about that water descriptor to be suppressed. Cross-reference is a mandatory entry, even if it is only self reference. The two digit entry and its reference are given in Table 3c. A shoreline descriptor should either self-reference (W2, W3, and WW default self reference) or they should cross-reference L0 through L9, and LL. Any erroneous cross-references or incompatible cross-references (a land descriptor is cross-referenced, but also given a negative vulnerability to suppress it) are flagged when the map file is loaded and an appropriate warning message is issued to the user.

LAGRANGIAN ELEMENT FILES

A Lagrangian element file can be created by OSSM. It is not a file for the user to create external to the OSSM system. Lagrangian elements are individual particles used to simulate a pollutant spill. Each element is tracked on the initialized maps in response to the initialized environmental information, such as winds, currents, diffusion, evaporation, weathering. The temporal and spatial distribution of the Lagrangian elements is taken to be the same as the distribution of the pollutant.

A Lagrangian element has several defining parameters. They are as follows:

LOCATION	(user-defined and model-updated)
RELEASE TIME	(user-defined and model-modified)
AGE	(user-defined)
POLLUTANT TYPE	(user-defined)
BEACHING HEIGHT	(model-computed)
MAP and STATUS	(model-computed)
STATISTICAL WIND KEY.	(model-computed)

Location is given by latitude and longitude. Release time is modified internally to be the number of hours since January 1, 1976, 00:00 hours. Age is the number of hours the oil has been exposed in the environment. For a fresh spill, this number is always zero hours. For a sighting of spilled oil, it should be some estimate of the number of hours the oil has already been exposed at the time it was sighted. Beaching height is calculated as the tidal height when the oil is beached, if a tidal height time file has been initialized (section 0.3.21). If the oil is not beached, beaching height is the tidal height at the current model time. Map and status are internal codes that indicate on which map the Lagrangian element is being tracked or if it has been transported outside the area bounded by all the initialized maps. Statistical wind key is an internal parameter utilized if the user is using statistical winds (climatological forecast modes) in the trajectory simulation (section 0.5).

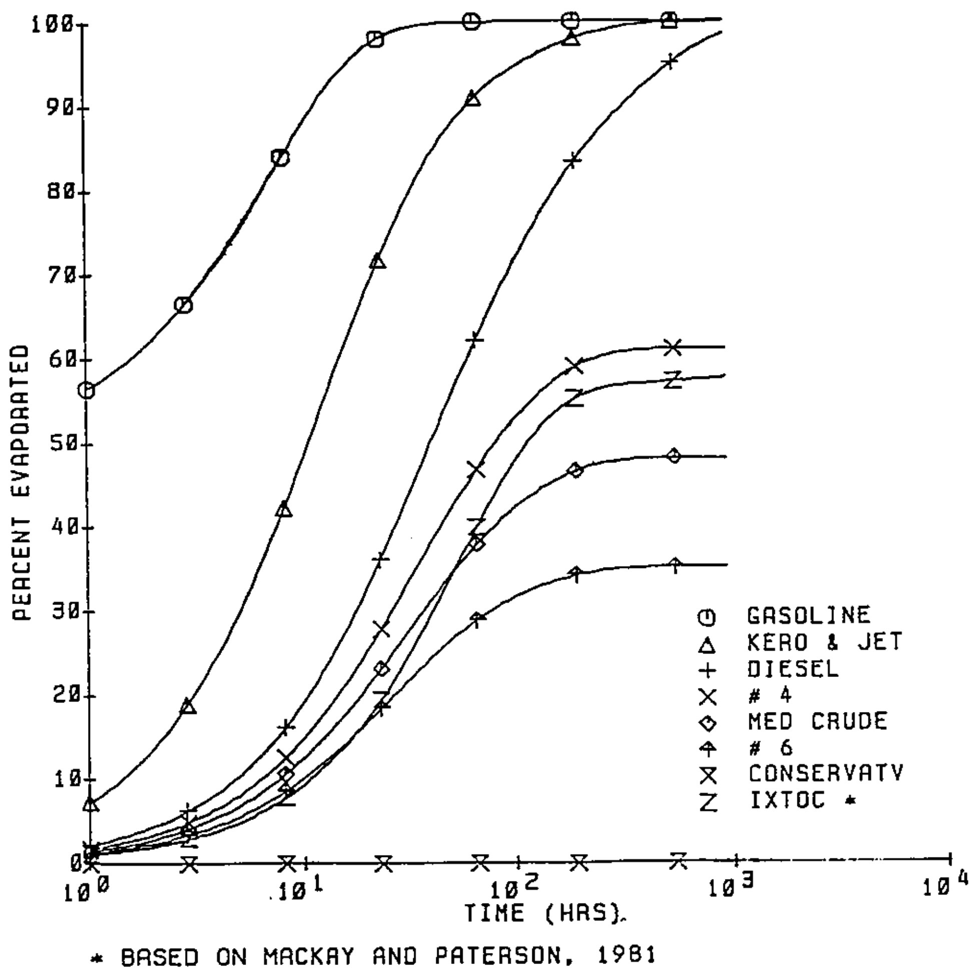
All Lagrangian elements are assigned a pollutant type when they are initialized. Each pollutant type has default parameters. The pollutant types and their associated default parameters are listed in Table 4. When a Lagrangian element "evaporates" or "decays", the pollutant type number is incremented by ten as an internal control. The Lagrangian element continues to be advected in the model and undergo the other processes such as beaching. At map print out time, the summary maps can either include or exclude the effects of evaporation (see section 0.7.10).

The pollutant type number selects one of the ten types of pollutants. The pollutant type describes the particular pollutant. Each pollutant is divided into three components, and each component has a half-life in hours associated with that particular component. OSSM performs a Monte-Carlo simulation to decide if a particular Lagrangian element has evaporated.

TABLE 4. Pollutant types, their default composition, and half-lives.

POLLUTANT #	POLLUTANT TYPE	PERCENT EACH CONSTITUENT	HALF-LIFE EACH CONSTITUENT (HOURS)	OBSERVATIONAL THRESHOLD TIME (HOURS)
1	GASOLINE	50.0	0.12	
		50.0	5.3	18.55
		0.0	1.0×10^9	
2	KEROSENE &	35.0	5.3	
	JET FUEL	50.0	14.4	50.4
		15.0	69.2	
3	DIESEL	30.0	14.4	
		45.0	48.6	170.1
		25.0	243.0	
4	# 4	24.0	14.4	
		37.0	48.6	170.1
		39.0	1.0×10^9	
5	MEDIUM	22.0	14.4	
	CRUDE	26.0	48.6	170.1
		52.0	1.0×10^9	
6	#6	20.0	14.4	
		15.0	48.6	170.1
		65.0	1.0×10^9	
7	USER	100.0	1.0×10^9	
	DEFINABLE	0.0	1.0×10^9	3.5×10^9
	SUBSTANCE 1	0.0	1.0×10^9	
8	USER	100.0	1.0×10^9	
	DEFINABLE	0.0	1.0×10^9	3.5×10^9
	SUBSTANCE 2	0.0	1.0×10^9	
9	CONSERV-	100.0	1.0×10^9	
	ATIVE	0.0	1.0×10^9	3.5×10^9
	SUBSTANCE	0.0	1.0×10^9	
10	DEFAULT	100.0	1.0×10^9	
	SUBSTANCE	0.0	1.0×10^9	3.5×10^9
		0.0	1.0×10^9	

Figure 8. Evaporation curves for default substances in OSSM.



There are, in addition, two user definable substances. The user may define up to three components for a particular substance and assign each component a half-life. The empirical Observational Threshold Time (OTT) is a parameter equal to 3.5 times the half-life of the second component for each pollutant type. If the exposure time for a pollutant exceeds the OTT, and there is less than one percent of the pollutant in an OSSM grid box, then the trajectory map will show the character "T" for that grid box to indicate a trace amount that may not be observable or detectable to personnel doing the field work during an actual spill.

A Lagrangian element file has the following structure and format:

LINE	DATA ITEM(S)	FORTRAN FORMAT
1	The number of Lagrangian elements	I5.
Line for each Lagrangian element	Latitude,longitude, release time, age, beaching height, map status, pollutant type, statistical wind key	F10.6,F10.6,F11.4, F11.4,F7.2,I4, I4,I4.
10 lines	For each pollutant type: Half-life of each constituent, Numerical coefficient for each constituent, percent each constituent, observational threshold time, pollutant descriptor (alphabetic)	10E15.6,A10.

WIND/CURRENT/SURFACE ELEVATION FILES

Grid Files

Two types of spatial data can be directly used in OSSM. The first type is generated by the DAC/SAC (Diagnostic Analysis of Currents/ Streamfunction Analysis of Currents) routines, and is known as a streamfunction grid. The second type is a set of vectors keyed by latitude and longitude from which OSSM will create a grid.

Streamfunction Grid Files:

A streamfunction grid is a set of vectors which can be loaded directly to OSSM's current/wind vector grids (Option 0.3.2). The current vectors are usually generated from the streamfunction or diagnostic model solutions for circulation along continental shelves and in enclosed harbors and estuarine areas. OSSM can generate a data file like this (Option 0.3.9). An OSSM current/wind grid contains 960 vectors. A streamfunction grid file contains the 960 U components (east-west) followed by the 960 V components (north-south). The components are loaded from left to right, starting at the north end (top) of the grid.

The streamfunction grid file has the following structure:

LINE	DATA ITEMS	FORMAT
1-96	960 east-west vector components	10F8.5
97-192	960 north-south vector components	10F8.5

Ordinarily, the vectors generated by the DAC/SAC routines have been normalized so that the largest magnitude is 1.0. It is the user's responsibility to key them with historical data or measurements.

Latitude-longitude/vector Files:

This is an externally created file used to input spatial information in OSSM. It may contain as few as one or as many as 960 lines or entries. Each entry is a vector keyed by location. The vectors can be from current atlases, measurements, numerical models, hypothetical descriptions of the current field, wind patterns, etc. Option 0.3.3 uses this data to fill a wind/current vector grid--each vector grid box is assigned the vector to which it is spatially closest. Additionally, OSSM can create a file like this from a vector grid (Option 0.3.9). A latitude-longitude/vector file has the following structure:

LINE	DATA ITEMS	FORMAT
1-960	Latitude degrees, latitude minutes, longitude degrees, longitude minutes, east-west velocity component, north-south velocity component.	Free field (data items separated by commas or spaces)

A current of 0.544 meters/second to the north at 45 degrees 15 minutes 30 seconds North latitude and 125 degrees 32 minutes 10 seconds West longitude would be coded as

45,15.5,125,32.17,0.0,0.5144.

Time-dependent Files

Time-dependent files are used to load time dependent data to OSSM (Option 0.3.22). Typical time dependent files are measurements of forecast winds, the amplitude of tidal currents at the entrance to bays and channels, and tide heights. A time dependent file may contain an unlimited number of entries; however, only one hundred entries can be loaded into any particular time file area. The user specifies at what date and time the file should be loaded, and then one hundred consecutive entries beginning after that date and time are loaded. OSSM uses a cubic Hermite interpolation to generate data at each time step from the time file areas.

A time dependent file has the following structure:

LINE	DATA ITEMS	FORMAT
as many as required	Day, month, year, hour, minute, value1, value2	Free field

Day, month, year, hour, and minute are all two digit integers (the time is 24 hour time). For vector-valued files, "value1" is the east-west component (east is positive) and "value2" is the north-south component (north is positive). For scalar valued files, "value1" is the scalar, and "value2" must be entered with a value of zero. A current of 0.5144 meters/second to the south for 16 December, 1980, at 16:45 hours would be coded as

16,12,80,16,45,0.0,-0.5144.

For a time-dependent tidal height file, a high tide of 0.3 meters on 16 December, 1980, at 16:45 hours would be coded as

16,12,80,16,45,0.3,0.0.

Note that "value2" has been coded as zero. The user can dump the contents of a time file area back to disk in the format of a time-dependent file (Option 0.3.25).

WIND HISTOGRAM FILES

A wind histogram file contains data from a wind histogram. OSSM allows the user to utilize eight speed classes, eight directions, and calm. Each entry is the percent occurrence of a given wind speed and direction. The general form of a wind histogram matrix is illustrated in Table 5. If fewer than eight speed classes or wind directions are needed, it is required that the "empty" spaces be coded with zeroes. The file format is given below:

LINE	DATA ITEMS		FORMAT
1		Speed-1,-2,-3,-4,-5,-6,-7,-8	Free field format
2	North	wind-1,-2,-3,-4,-5,-6,-7,-8	
3	North-east	wind-1,-2,-3,-4,-5,-6,-7,-8	
4	East	wind-1,-2,-3,-4,-5,-6,-7,-8	
5	South-east	wind-1,-2,-3,-4,-5,-6,-7,-8	
6	South	wind-1,-2,-3,-4,-5,-6,-7,-8	
7	South-west	wind-1,-2,-3,-4,-5,-6,-7,-8	
8	West	wind-1,-2,-3,-4,-5,-6,-7,-8	
9	North-west	wind-1,-2,-3,-4,-5,-6,-7,-8	
10	Calm.		

TABLE 5. Wind histogram matrix.

SPEED	1	2	3	4	5	6	7	8
DIRECTION*								
NORTH	%	%	%	%	%	%	%	%
N-E	%	%	%	%	%	%	%	%
EAST	%	%	%	%	%	%	%	%
S-E	%	%	%	%	%	%	%	%
SOUTH	%	%	%	%	%	%	%	%
S-W	%	%	%	%	%	%	%	%
WEST	%	%	%	%	%	%	%	%
N-W	%	%	%	%	%	%	%	%
CALM	%							

*Follows meteorologists' convention: a north wind blows to the south.

The speeds of a histogram should be in meters/second. If they are not, the histogram multiplicative factor (Option 0.5.6) can be appropriately adjusted to scale them to meters/second. The percent for each wind direction and speed can be entered as percent, or as some constant multiple of percent because the load option (Option 0.5.2) automatically scales the total to 100 percent. Calm is a single data item associated with zero speed. It is not necessary to use the entire matrix, but it is mandatory that all unused items be coded with zeroes. For example, a wind histogram consisting of the equally probable speeds of 5, 10, and 15 meters/second and the directions N, S, E, and W, where the north winds are twice as probable as the other directions could be coded as:

```
5,10,15,0,0,0,0,0    or as 0,0,15,0,5,0,0,10
2,2,2,0,0,0,0,0            0,0,2,0,2,0,0,2
0,0,0,0,0,0,0,0            0,0,0,0,0,0,0,0
1,1,1,0,0,0,0,0            0,0,1,0,1,0,0,1
0,0,0,0,0,0,0,0            0,0,0,0,0,0,0,0
1,1,1,0,0,0,0,0            0,0,1,0,1,0,0,1
0,0,0,0,0,0,0,0            0,0,0,0,0,0,0,0
1,1,1,0,0,0,0,0            0,0,1,0,1,0,0,1
0,0,0,0,0,0,0,0            0,0,0,0,0,0,0,0
0                          0.
```

The ordering of the speeds is up to the user, although the first file is easier to understand, than the second coded version of the same data. The three speeds could have been assigned to any column, as long as the percent for wind and speed was put in the appropriate column. The extra zeroes are required to fill in the data file. The correct percent for each wind/speed class will automatically be computed. NOTE: THE WIND DIRECTIONS IN THESE ROUTINES OBEY THE METEOROLOGICAL CONVENTION--A NORTH WIND IS A WIND BLOWING TO THE SOUTH. If the user prefers to use the oceanographic convention instead, the multiplicative factor (Option 0.5.6) should be negative.

USER DEFINED AND FORMATTED FILES

If the user chooses to write processing options based on the data structures loaded into OSSM, the options should be placed in the USER ROUTINES overlay. It is the user's responsibility to document any files or data structures he or she creates.

INITIALIZATION FILES

The checkpoint or initialization files are written by OSSM. It is a formatted dump of the common variables. The data items and the Fortran Formats are not given as this is primarily an internal OSSM file. If the user desires to inspect the file, the user should consult the OSSM program listing. No upward compatibility has been designed for the initialization files in the several versions of OSSM. If a user desires to use the same data in future releases of OSSM, the individual pieces should be saved (map files, grid files, time files, etc.) instead of the checkpoint files. The checkpoint files will be different for every future version of OSSM.

DIAGNOSTIC ANALYSIS OF CURRENTS (DAC) AND STREAMFUNCTION ANALYSIS OF CURRENTS (SAC) FILES

Vertex and Boundary Data Files

The vertex and boundary specification data are used only for plotting purposes. The file may contain up to 200 entries for vertices and up to 20 entries for boundary segments. This file is the same as the DAC/SAC file called VERDAT. Refer to the DAC/SAC documentation. The file structure and format are given below.

LINE	DATA ITEMS	FORMAT
1-variable	Station Number, OSSM horizontal coordinate, OSSM vertical coordinate, depth. (0,0,0,0 terminates this portion)	Free-field Format
	Number of boundary segments.	Free-field Format
	Last station number of each boundary segment.	Free-field Format

Triangle Data Files

The triangle data are used only for plotting purposes. The file may contain up to 400 entries for triangles. This file is the same as the DAC/SAC file called TOPDAT. Refer to the DAC/SAC documentation. The file structure and format are given below.

LINE	DATA ITEMS	FORMAT
1	Number of triangles.	I10
2-variable	Station number 1, station number 2, station number 3 (the three stations forming each triangle).	3I10

Streamfunction Data Files

The streamfunction and diagnostic model values are used only for plotting purposes. The file may contain up to 200 entries. These files are the same as the DAC/SAC files called DMVAL and STREAM. Refer to the DAC/SAC documentation. The file structure and format are given below.

	LINE	DATA ITEMS	FORMAT
SAC	1-variable	Station number, streamfunction value.	I10,F10.3
		Station number, amplitude value.	I10,F10.3
DAC	1-variable	Station number, hinge value 1, hinge value 2, hinge value 3, hinge value 4.	I10,4F10.3

DATA FROM FIELD SAMPLING PROGRAMS FILES

Wind and Current Measurements Files

This user-created data file usually contains measurements of both currents and winds at a specific site at a specific time. Its sole purpose is for obtaining a least-squares fit between the current measurements and grid patterns (Option 0.3.11). The file structure and format are given below.

LINE	DATA ITEMS	FORMAT
one line per entry	Degrees latitude, minutes latitude, degrees longitude, minutes longitude, east-west water velocity, north-south water velocity, east-west wind velocity, north-south wind velocity, day, month, year, hour, minutes.	Free field format

Other Field Sampling Data Files

These files contain the date, location, depth, and values of a particular sample, along with the units and a comment for each sample collected during a spill. The user has the option of listing the data or plotting and listing the data sites. The file structure and format are given below.

LINE	DATA ITEMS	FORMAT
1	80 column header or title line.	8A10
2	"V" for vector values, "S" for scalar values.	A1
3	Day, month, year, hour, minute, degrees latitude, minutes latitude, degrees longitude, minutes longitude, depth, value1(, value2).	Free-Field Format
4	Units, comment.	A10,7A10

Lines 3 and 4 are repeated until all the data samples are included. "Value2" is only used for vector-valued samples. Comment is for any comment or sample identifier the user may wish to designate. The following is a data file with two data items:

```
THIS IS A SAMPLE VECTOR DATA FILE FOR ILLUSTRATIVE PURPOSES
V
20,8,80,12,30,49,33.25,127,45.10,0,15.3,-10.2
M/S    WIND DATA IS THE COMMENT ILLUSTRATED
20,8,80,13,00,49,56.75,128,0.0,0,14.7,-7.2
M/S    WIND DATA FROM R/V THOMPSON
```

E. SEQUENCE PATH OPTIONS

OSSM is divided into eleven main options. The eleven main options are divided into initialization options and informational options. The initialization options include handling the initialization of maps, pollutant distribution and parameterization, keying and scaling spatial and time dependent vector and amplitude data, diffusion, and statistical options. The informational options include trajectory runs, concentration maps, receptor mode mappings for trajectories, summaries of parameters, processing of checkpoint files, conversion of OSSM coordinates to latitude and longitude, processing of initialization data, high-resolution hard-copy graphics, and processing of data from field sampling programs.

A listing of all sequence path response codes and options is contained in Appendix A, a quick reference to the user-available options in OSSM. A detailed listing of the actual code and a summary of all routines and functions will be contained in a companion publication, A Programmer's Guide to OSSM.

MAIN OPTION:

Main option is the main control sequence of OSSM. All options are branched to from the Main option. The sequence path response codes and their associated sections are as follows:

0.0 MAIN OPTION?

1 INITIALIZE MAPS
2 INITIALIZE LAGRANGIAN ELEMENTS
3 INITIALIZE WINDS/CURRENTS/SURFACE ELEVATIONS
4 INITIALIZE SPREADING/DIFFUSION
5 INITIALIZE STATISTICAL WINDS
6 INITIALIZE USER ROUTINES
7 TRAJECTORY RUNS AND CONCENTRATION MAPS
8 LIST/READ/SAVE INITIALIZATION
9 LOCATE GEOGRAPHICAL POSITIONS
10 CALCOMP PLOTTING
11 LIST/PLOT DATA SITES

999 END OF JOB.

Each section is further explained under its appropriate heading. The Main Option section resides in the zero overlay. All of the main option sequence path response branches are separate overlays. In all main options, the sequence response entry of "99" will always return the user to the prior level. The sequence response entry "89" is usually reserved for informational summaries.

0.1.0 INITIALIZE MAP(S)

The initialize maps overlay allows the user to read (Option 0.1.1) and manipulate the files containing the coastal boundaries and optional shoreline descriptors. An OSSM map contains a title, the bounding latitudes and longitudes, and then a summarized (coded) description of the area (refer to section D, Map Files and Optional Shoreline Descriptors). The optional shoreline descriptors may be added if the user desires values different from the default values. All shoreline descriptor parameters can be set differently for each map. Option 0.1.2 allows the user to delete a map file and its linked data bases.

In OSSM, the user may have up to three maps defined at the same time. The maps may be overlapping and adjacent (extending the existing model to a new area), overlapping and embedded (main model with submodels configuration), or disjoint (distinct non-connected models run simultaneously (in practice, no one would ever do disjoint configurations although it is allowed)). In order for OSSM to maintain a logical structure for the physical configuration, the user indicates the physical configuration by a priority code (Option 0.1.3). The priority code default is "L" (low). Low is used when there is a single map. If multiple maps are used, the higher priority codes, "M" (middle) and "H" (high) may be assigned to them. Higher priority codes indicate that a map with a higher priority is embedded in a map of lower priority. Maps that are merely adjacent or disjoint should be given the same priority. Practically, when the centroid of a Lagrangian element is located on more than one map, it will automatically be tracked on the map of highest priority. For example, in Figure 6 the entire Gulf of Mexico map is shown, along with the map for the northeast Gulf of Mexico, and the three higher resolution maps for the Brownsville, Corpus Christi, and Galveston areas. If OSSM were being run with the Gulf of Mexico, the northeast Gulf of Mexico, and the Brownsville maps, the Gulf of Mexico would have priority L, the northeast Gulf of Mexico priority M, and the Brownsville map priority H. This defines their embeddedness. A Lagrangian element near Brownsville would be tracked on the Brownsville map, and would be affected only be velocity fields defined for the Brownsville map. Additionally, if one were using the northeast Gulf of Mexico, the Corpus Christi and Galveston maps, the northeast Gulf of Mexico would be given priority L, and the Corpus Christi and Galveston maps both priority M (adjacent and overlapping and embedded in the northeast Gulf of Mexico map.)

Option 0.1.4 allows the user to suppress the printing of any particular map during summary output. If the trajectories are not needed for the lower priority maps, it is not necessary to print out the lower priority maps. Options 0.1.3 and 0.1.4 can be utilized together to allow the user to do atmospheric plume modeling with a coastal outline. The user would set up two maps, one with the coastline and a second map of the same area, but showing it as all water. The map without the coastline would be given the higher priority in order that the Lagrangian elements not see the coastline. The map with the higher priority would be suppressed during summary output and the Lagrangian elements printed on the map with the coastline. Of course it would be necessary to modify the velocity fields and diffusion coefficients accordingly.

Figure 9. Gulf of Mexico and adjacent areas showing Northwestern Gulf, Brownsville, Corpus Christi, and Galveston submodels.

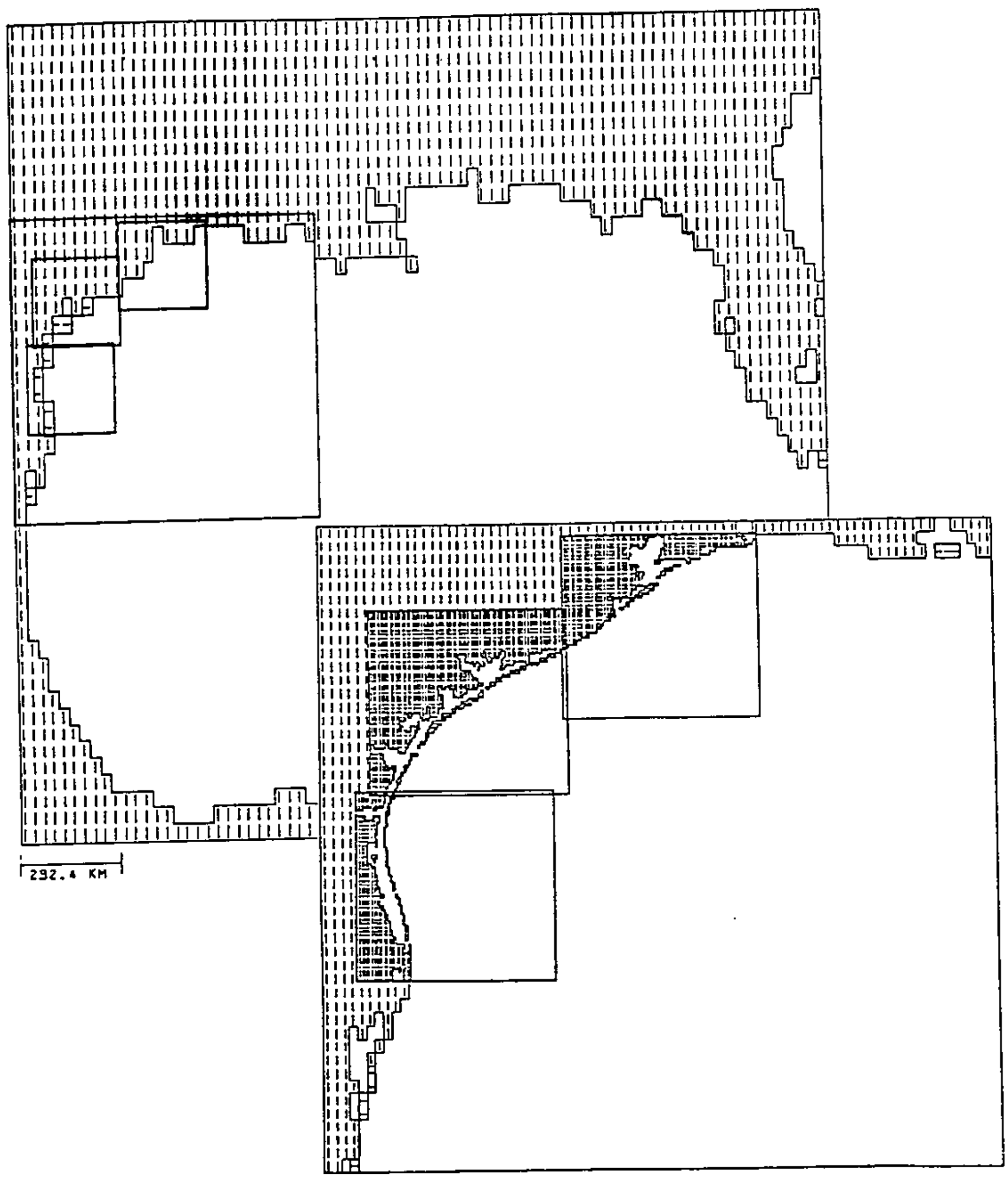


Figure 10. Cape Fear River showing the use of adjacent models.

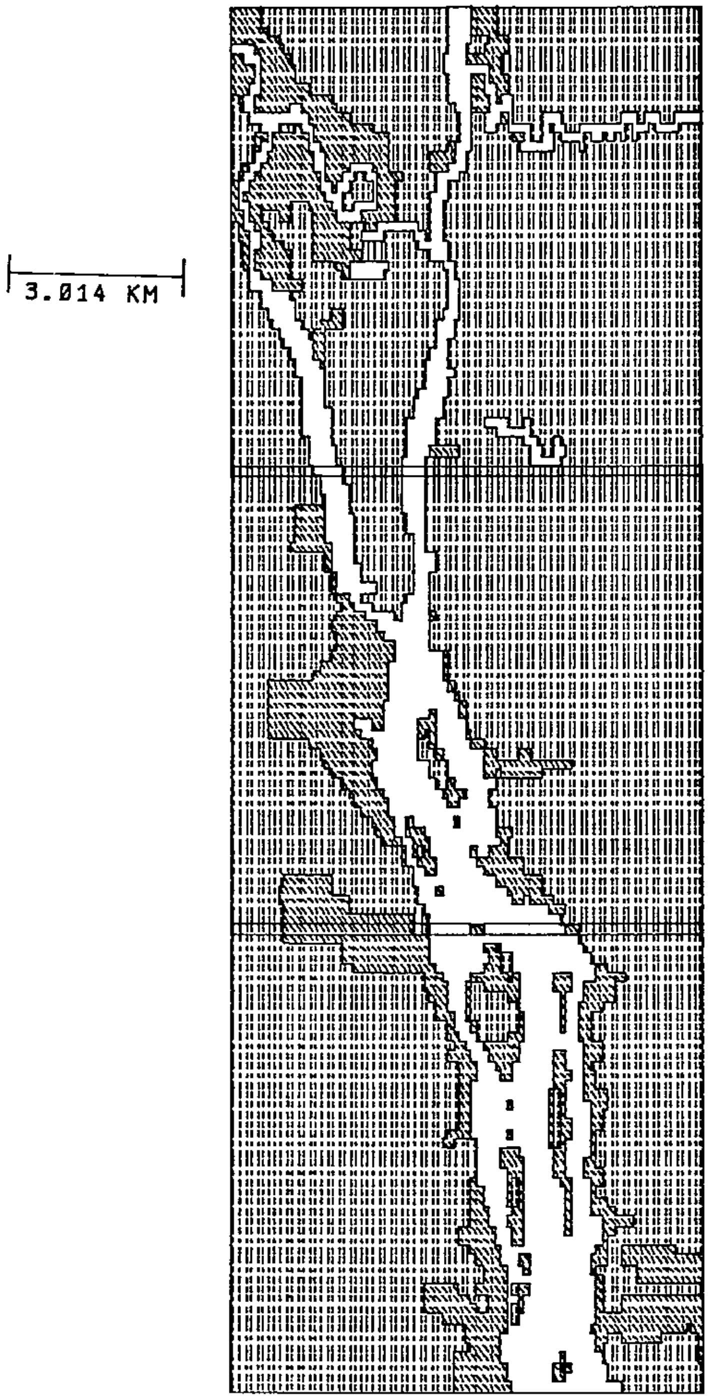
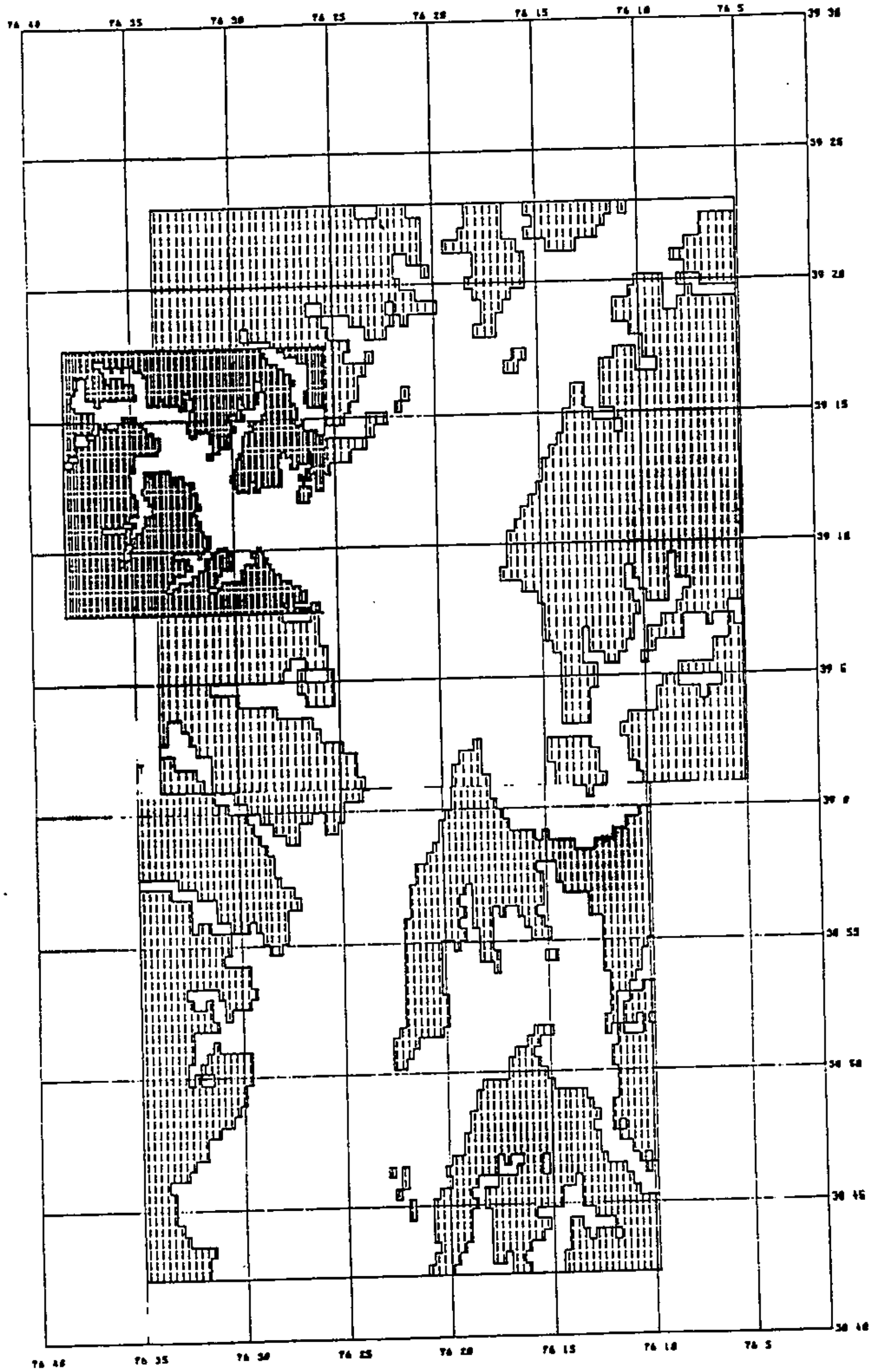


Figure 11. Adjacent models for the Chesapeake Bay with embedded model for Baltimore Harbor.



Option 0.1.5 allows the user to cross load maps and shoreline descriptors. Data at one scale can be incorporated in a map on another scale.

Option 0.1.6 allows the user to annotate the blank positions of a concentration map with latitude and longitude lines. The lines are loaded in the printed map as close as possible to their actual positions. Obviously the accuracy of their placement is a direct function of map resolution. All lines so positioned are relative to a whole degree, not to the edge of the map. For example if the user designated longitude/latitude lines every 15 minutes, and the edge of the map was at 18 degrees 47.3 minutes, the first line would be at 19 degrees, the next at 19 degrees 15 minutes, and so forth.

Option 0.1.7 allows the user to restore the map to the disk. The optional shoreline descriptors (default or modified) are added to the end of the map file for the user's perusal and potential modification.

Option 0.1.8 prints out a coded map which identifies the shorelines and prints a legend for the shoreline descriptors in use for this map and their default or modified parameters.

Option 0.1.89 summarizes what has been initialized for maps. Option 0.1.99 ends the map initialization options and returns the user to the main option.

The sequence path response codes and their associated sections are as follows:

0.1.0 INITIALIZE MAP(S)

1 LOAD MAP FILE AND OPTIONAL SHORELINE DESCRIPTORS
2 DELETE A MAP FILE AND ITS LINKED DATA BASES
3 SET MAP FILE PRIORITY (L, M, H)
4 DESIGNATE/CANCEL MAP PRINTED DURING SUMMARIES
5 CROSS LOAD MAPS AND SHORELINE DESCRIPTORS
6 SET LAT/LONG LINES FOR PRINTER MAPS
7 DUMP MAP TO DISK
8 PRINT MAPS

89 SUMMARIZE ALL MAP PARAMETERS

99 END INITIALIZE MAP OPTION

0.1.1 LOAD MAP FILE AND OPTIONAL SHORELINE DESCRIPTORS

The user is requested to specify the permanent file name of the file containing the map (refer to Map Files and Optional Shoreline Descriptors). The user must specify a unique (different) name for each map used. Loading a map file that already is loaded will cause that map file area to be reloaded, but will leave all data linkages associated with the map intact. This is useful for correcting maps. If all three maps areas are in use, the user will have to delete a map before another is initialized. Internally, the map is packed in a binary (hexadecimal) format by a routine called HEXAL. This routine compacts the 80 by 48 map into an array 6 words by 48 words. The subroutine IHEX is used to retrieve any portion of the map. The valid map descriptors are given in Table 3a. Any shoreline descriptor which is not one of the sixteen listed is automatically converted to "WW". The map is checked for spatial distortion and optional shoreline descriptor compatibility.

0.1.2 DELETE A MAP FILE AND ITS LINKED DATA BASES

This option deletes a map file and all of its parameters. Grids defined for this map are deleted. Linkages to time dependent files are cancelled. Trajectories being tracked on the cancelled map are reassigned to the other maps if possible.

0.1.3 SET MAP FILE PRIORITY (L, M, H)

Map file priority is used to specify a logical structure between the maps being used to define the physical area. In OSSM, the user may have up to three maps defined at the same time. The maps may be overlapping and adjacent (extending the existing model to a new area), overlapping and embedded (main model with submodels configuration), or disjoint (distinct non-connected models run simultaneously (in practice, no one would ever do disjoint configurations although it is allowed)). In order for OSSM to maintain a logical structure for the physical configuration, the user indicates the physical configuration by a priority code (Option 0.1.3). The priority code default is "L" (low). Low is used when there is a single map. If multiple maps are used, the higher priority codes, "M" (middle) and "H" (high) may be assigned to them. Higher priority codes indicate that a map with a higher priority is embedded in a map of lower priority. Practically, when the centroid of a Lagrangian element is located on more than one map, it will automatically be tracked on the map of highest priority.

0.1.4 DESIGNATE/CANCEL MAP TO BE PRINTED DURING SUMMARIES

It is not necessary to print out every map and summarize the trajectories on it during a summary print. The default is every map will be printed during a summary print. If the user wishes to bypass the output of a particular map, this option should be used.

0.1.5 CROSS LOAD MAPS AND SHORELINE DESCRIPTORS

This option allows the user to create a map from other maps at different scales. The user creates a receiving map with the desired bounding latitudes and longitudes. It may be set up as a map completely water covered or as an actual coded OSSM map. A sending map is designated.

Each receiving OSSM grid box is subdivided into 16 sub-grid boxes. These locations are used to fetch shoreline descriptors from the sending map. The shoreline descriptor with the highest vulnerability for all the sub-grid boxes is then coded into the receiving map. Only the intersection of the two map areas is affected. Optional and default shoreline descriptors are transferred to the receiving map.

0.1.6 SET LAT/LONG LINES FOR PRINTER MAP

This option allows the user to have latitude and longitude lines printed on the printer plot. The lines are placed only in blank positions of the map so no output will be lost. Obviously, the accuracy of the lines is directly related to the map resolution. Nonetheless, experience has shown that this is a valuable option to initialize. The default is no lines. All lines so positioned are relative to a whole degree, not to the edge of the map. For example, if the map edge were at 18 degrees 47.3 minutes and the user specified lines every 15 minutes, the first line would be at 19 degrees, the second at 19 degrees 15 minutes and so forth.

0.1.7 DUMP MAP TO DISK

This option recreates the map file on disk and appends to it the shoreline descriptors in use for this map. This allows the user to change them more easily than if they were coded initially. Additionally, if the user does modify the optional shoreline descriptors, the map can be reloaded.

0.1.8 PRINT MAPS

The user can have all (or some) maps printed out. Only maps which have been designated to print (the default for Option 0.1.4) will be printed. These maps are printed utilizing codes for the shoreline descriptors with a legend at the bottom of the maps, along with the default or modified parameters in effect for the shoreline descriptors.

0.1.89 SUMMARIZE ALL MAP PARAMETERS

This option lists all maps and parameters initialized (or defaulted). The same routine is used during a summary break when model running parameters are summarized.

0.1.99 END INITIALIZE MAP OPTION

Return to Main Option.

0.2.0 . INITIALIZE LAGRANGIAN ELEMENTS

The spilled pollutant is modeled as a collection of discrete parcels or blobs, known as Lagrangian elements. Any actual quantity of spilled pollutant may be assigned to each discrete parcel. This overlay allows the user to specify

1.) How many Lagrangian elements will be used to model the spill;
2.) The physical location of the oil (either spill site or oil distribution from aerial reconnaissance);
3.) The date and time of release or sighting; and
4.) The pollutant type, age, and observational threshold time.

There are several different initialization sections. Any combination of sections may be used and reused until all Lagrangian elements have been initialized. A thousand Lagrangian elements are allowed. Since many of the options have similar parameters, a brief description of the common parameters will be given.

1.) Number of Lagrangian element to initialize

If this number exceeds the number available, the number available will be used. If the user enters 0 or a negative number, the option will be bypassed. The user should choose a number of Lagrangian elements that allows for easy convertibility between the quantity of Lagrangian elements and the quantity of the spilled substance.

2.) Start date

This is the release or appearence date of the Lagrangian element in the system. Until the current model time exceeds this date, the Lagrangian element is not released into the system. If a user has data containing several sightings at different times, the sighting times become the start dates for the Lagrangian elements.

3.) Release position

This is always given as degrees latitude, minutes latitude, degrees longitude, and minutes longitude. The minutes of latitude and longitude contain the decimal fractional equivalent of the seconds.

4.) Pollutant type, age, and observational threshold time

These parameters control the evaporation (weathering and empirical accomodation) routines. Table 4 lists the pollutant types, their default composition, and the half-lives of their components. The first six pollutant types are divided into three-component mixtures, each component with a different half-life. Pollutant types 7 and 8 allow the user to specify a three-component mixture and specify the half-life and percent of total mixture for each component. Pollutant types 9 and 10 are identical. Both assign the Lagrangian element to a conservative quantity, which is neither evaporated (or decayed) nor empirically accomodated into the water column or atmosphere. This is the choice for substances for which little is known. If the user does not care for the half-lifes and the percent of the mixture assigned to it, pollutant types 7 or 8 can be used to designate a substance and give it the half-lifes and percent of the mixture which the user desires. The option will always print out what the default half-lives and percents are.

Age is the age in hours of the Lagrangian element at its release time (usually 0 hours if just spilled) or its probable age at its sighting (usually not zero). If the pollutant was released two days before it is sighted, its age would be 48.0 hours. Age is important because it determines partly the probability that a Lagrangian element will decay or evaporate in a given time step. For example, approximately half of freshly spilled gasoline will completely evaporate in one hour. If the age of some spilled gasoline is 24 hours, it is almost certain that none of it will evaporate in the first hour of running the model. The period of high probability of evaporation has already occurred.

The user is given an observational threshold time in hours and asked to accept it, or reject it and specify a new one in hours. The observational threshold time (OTT) is usually equal to 3.5 times the half-life of the second constituent for a pollutant type. When the percent of Lagrangian elements anywhere on the map falls to less than 1 percent, and the average age of the Lagrangian elements in that box exceeds the average OTT, the OSSM map code becomes a T meaning trace amount. If this feature is not desired, the user should redesignate the OTT to be a long time (3.5×10^9 hours is appropriate).

5.) Status Code

Each L. E. is assigned a status code by the system. The codes and their meanings are as follows:

CODE	MEANING
0	Lagrangian element not yet assigned to a map
1, 2, or 3	Being tracked on map 1,2, or 3.
4, 5, or 6	Beached on map 1,2, or 3.
7	Lagrangian element not on any map (position frozen).
8	Lagrangian element beached and map subsequently cancelled.

The sequence response path codes and their associated sections are as follows:

0.2.0 INITIALIZE LAGRANGIAN ELEMENTS

1 CLEAR LAGRANGIAN ELEMENTS
2 INITIALIZE LINE OR POINT SOURCE
3 INITIALIZE CIRCULAR DISTRIBUTION RANDOMLY
4 INITIALIZE BY OSSM COORDINATES
5 INITIALIZE FROM DISK FILE
6 WRITE TO DISK FILE
7 LIST A RANGE OF LAGRANGIAN ELEMENTS
8 RESTORE DEFAULT EVAPORATION AND WEATHERING PARAMETERS

89 SUMMARY OF LAGRANGIAN ELEMENTS

99 END INITIALIZE LAGRANGIAN ELEMENTS OPTION

0.2.1 CLEAR LAGRANGIAN ELEMENTS

Lagrangian element are deleted by number and the storage area is compacted. This resets the data locations for all Lagrangian element that were initialized later and have a higher number. If the user wishes to delete several ranges of Lagrangian element, the highest ranges should be deleted first as deleting the lower ranges will reset the positions where all the higher ranges of Lagrangian element are stored. For example, if 300 Lagrangian element were initialized and the user wished to delete 100 to 125 and 175 to 200, 175 to 200 should be deleted first and then 100 to 125 deleted.

0.2.2 INITIALIZE LINE OR POINT SOURCE

This option is used for initializing point sources that discharge continuously or all at once, and line sources that are observed, or result from a moving leaking vessel. The user is asked to specify the following parameters:

1.) Number of Lagrangian element to initialize;
2.) Start (release) position;
3.) Start (release) date and time;
4.) End (release) position (if different from start (release) position).
5.) End (release) date and time (if different from start (release) date and time;
6.) Pollutant type, age, and observational threshold time.

The user is requested to signify that the parameters entered are correct. If so the Lagrangian element are initialized. If not, the Lagrangian elements are not initialized. If the end (release) position or date and time is different, the routine distributes the Lagrangian elements linearly along the difference in time or space or both.

0.2.3 INITIALIZE CIRCULAR DISTRIBUTION RANDOMLY

This option is used for initializing a circular distribution, randomly filled. The start date and time is the same for all Lagrangian element initialized by a single use of this option. The user is asked to specify the following parameters:

1.) Number of Lagrangian elements to initialize;
2.) Center for circle (latitude and longitude);
3.) Release date and time;
4.) Circle radius in kilometers,
5.) Pollutant type, age, and observational threshold time;
6.) Do you wish to reenter any above parameters?
7.) Compare points against a map and discard onshore Lagrangian elements?
8.) Are the results acceptable to the user?

If the circle should overlap a land area, the user can specify one map to check against the random Lagrangian element positions. The onshore points will be discarded. If 20 consecutive attempts to assign a position to a specific Lagrangian element all land on land or islands, the routine is interrupted and the user is given the opportunity to bypass the option. A no will cause the routine to be bypassed and the points will not be initialized. This prevents the program from looping if the user has inadvertantly specified all initialization to take place over land areas and has actually desired the initialization to take place in water areas.

0.2.4 INITIALIZE BY OSSM COORDINATES

This option allows the user to initialize the Lagrangian elements by utilizing their positions on the printer map. The Lagrangian elements are loaded to a random position inside the designated OSSM box. The user is asked to specify the following parameters:

1.) Specify which map to use;
2.) Start (release) date and time for Lagrangian element;
3.) Pollutant type, age, and observational threshold time;

DO-UNTIL LOOP:

4.) Enter I,J,N where I is the map column
J is the map row, and
N is the number of Lagrangian elements.

DO-UNTIL LOOP FINISHED.

The upper-left corner of the map has OSSM coordinates I=1,J=1. The lower-right corner has OSSM coordinates I=80,J=48. Enter -999,9,9 to undo last entry. Enter 999,9,9 to terminate entering values.

0.2.5 INITIALIZE FROM DISK FILE

The user may request that the output from Option 0.2.6 be used to reinitialize the system. A disk read will clear any Lagrangian elements that have already been stored, and re-initialize the entire Lagrangian elements working area.

0.2.6 WRITE TO DISK FILE

This option saves the Lagrangian element currentlys in the system, along with their status codes. The user must supply an output file name. If the output file name already exists, it will be written over.

0.2.7 LIST A RANGE OF LAGRANGIAN ELEMENTS

This option lists a user supplied range of Lagrangian elements, their present positions, and status codes.

0.2.8 RESTORE DEFAULT EVAPORATION AND WEATHERING PARAMETERS

If the user has inadvertantly or deliberately changed any of the evaporation and weathering parameters, this option allows the user the restore them to their default values.

0.2.89 SUMMARY OF LAGRANGIAN ELEMENTS

This option summarizes the first and last Lagrangian elements initialized. This routine is also used during summary breaks to inform the user about active initializations.

0.2.99 END INITIALIZE LAGRANGIAN ELEMENT OPTION

Return to Main Option.

0.3.0 INITIALIZE WIND/CURRENT/SURFACE ELEVATIONS

The initialize wind/current/surface elevations overlay allows the user to define and allocate storage for spatially dependent data, time dependent data, and spatial patterns convoluted with time dependent amplitude files.

Grid Areas

Spatially dependent data are stored in arrays referred to as "grids." Each grid is either a wind grid or a current grid. Grids are assigned to maps. Assigning a grid to a map means that the grid will cover the same physical area the map covers. The resolution of a velocity field in a grid is one quarter the resolution of the OSSM map (the grid is 40 by 24, the OSSM map is 80 by 48; each velocity grid box covers four OSSM map grid boxes). A total of twelve (12) grid areas are available for simultaneous use in OSSM.

Data for grids comes in two forms (see Data File Formats). The first is loaded by Option 0.3.2 and is a file with 40 by 24 vectors, already defined to cover the same physical area the map file covers. This data type is primarily the output from the Streamfunction Analysis of Currents (SAC) and the Diagnostic Analysis of Currents (DAC). The second type of data is loaded by Option 0.3.3, and is a file containing current vectors keyed by location (latitude and longitude). Option 0.3.3 generates the grid vectors by assigning to each grid vector box the keyed vector closest to it. The grid contents can be dumped to the disk storage area either as a streamfunction block (40 by 24 vectors) or as a latitude-longitude/velocity file by Option 0.3.9.

All data is assumed to have units of meters/second. Associated with each grid is a multiplicative and additive factor (Option 0.3.8) for scaling the data. The multiplicative factor is complex, allowing for rotation. The additive factor is also complex (the east/west velocity (U positive to east) being the real part, the north/south velocity (V positive to north) being the imaginary part. Usually the additive factor is always zero, and the multiplicative factor is 1.0 +0.0*SQRT(-1.) for currents and surface elevations, and .03 + 0.0*SQRT(-1.) for winds (three percent of the wind speed). These values are set automatically, but can be changed.

Grids can be smoothed by the following formula (Option 0.3.4):

$$\overline{U}_{i,j} = 0.4 * \overline{U}_{i,j} + 0.15 * (\overline{U}_{i-1,j} + \overline{U}_{i+1,j} + \overline{U}_{i,j-1} + \overline{U}_{i,j+1})$$

At the edges and corners, the weighting is compensated to handle the lack of four adjacent data points.

The grid can be "plotted" on the printer. The grid is scaled by the largest absolute value. Characters 1 through 9 represent positive velocities, A through I, negative velocities. I and 9 correspond to each other in magnitude. There is a separate plot for U and V components.

Each grid is evaluated at a single specified location during the summary print. The default is to evaluate the grid at its center.

Alternately, Option 0.3.7 allows the user to specify the location (latitude and longitude) where it will be evaluated for summary print purposes. This option is useful for normalizing or scaling the current or wind patterns at a given location.

The grid can be zeroed over land and islands (Option 0.3.5). It is zeroed only if all four of the corresponding OSSM map boxes are not water.

A grid may be added to another grid even though they are assigned to different maps and cover different areas (Option 0.3.10). The non-zero intersection of the two grids is added to the receiving grid. A word of caution is in order: the value added to the receiving grid will be the average of the non-zero vectors evaluated at the center of the four OSSM boxes that lie in the receiving grid box. The sending grid sends U and V components which include the sending grids multiplicative and additive factors. The receiving grid they are added to are the grid values that do not include the multiplicative and additive factors of the receiving grid.

Time File Areas

Time dependent data is stored in time file areas. Time file areas contain wind data, surface elevation data (usually tide heights) and current amplitude data (usually amplitudes of tidal currents). A maximum of 100 velocity vectors keyed by date and time can be loaded into any time file area. A time file area may load a time dependent file beginning at any user specified time. A total of six (6) time file areas are available.

Time file areas can be plotted (Option 0.3.23) beginning and ending at any user specified time and interval. The U component is coded U; the V component is coded V; when they both have the same scaled amplitude, the code used is B; if both have values 0.0, just a period (.) is printed on the axis.

Similar to grids, time file areas have multiplicative and additive factors for scaling the data; the data is assumed to have dimensions of meters/second for vector data, and meters for surface elevation data. The multiplicative factor is complex, allowing for rotation. The additive factor is also complex, the east/west velocity (U positive to east) being the real part, the north/south velocity (V positive to north) being the imaginary part. Usually the additive factor is always zero, and the multiplicative factor is 1.0 +0.0*SQRT(-1.) for currents and surface elevations, and .03 + 0.0*SQRT(-1.) for winds (three percent of the wind speed). These values are set automatically, but can be changed.

Time file areas can be dumped back to disk (Option 0.3.25). The user can calculate the time derivative of a time file area and store it in a different time file area and have it labeled as a derivative (Option 0.3.26). If the time file contains tidal current data, it can be modified for leads or lags in the ebb, flood, and slack water times as well as ebb and flood velocity ratios (Option 0.3.27).

Time file areas can be joined to maps, or grids, or both (Options 0.3.40 and 0.3.41). Joining a time file area to a map means that all Lagrangian elements on that map will feel the velocity data in the time file area. Joining a time file to a grid means that the grid vectors will be multiplied by the time file vectors (as complex data). What this means practically is that a time dependent amplitude file such as the tidal velocity at the mouth of a channel can key a spatial pattern, such as a streamfunction pattern of the dominant ebb and flood directions. In most cases, this could be done by using just the real (U component) of the time file area to be the amplitude (with units) and the flow pattern to be dimensionless with unit amplitude at the same position the tidal velocity is known. There is no limitation on the number of combinations of joinings. A time file area may be joined simultaneously to different maps and different grids. A grid may be joined to different time file areas at the same time. Only by joining a time file area to a map or grid, will it contribute to the overall velocity field.

In order to do a climatological model for the Gulf of Mexico, OSSM was supplied with a numerical model of the surface currents as monthly patterns. A time file was created for each month with unit amplitude at the middle of the particular month, tapering to zero at the middle of the two adjoining months. By joining the time files to the current files, we were able to linearly interpolate between monthly currently patterns.

Another example of how this feature can be used is as follows. Time dependent wind data are available for different locations. Latitude-longitude/velocity files are coded, such that for every station, the U-component of velocity has unit amplitude at the station and zero amplitude at the other stations. By loading this data to grids and joining the grids to the time dependent data, we then get a time dependent velocity field such that at each location the velocity is keyed by the station that is spatially closest.

A final example is having a long time file. It can be segmented into separate time file areas such that the endpoint of one time file area is the same data as the starting point of another time file area. Each time file area is then joined to maps or grids as required. This results in a continuous stream of data from the time file areas--when one time file area turns off, another turns on.

The sequence path response codes are as follows:

0.3.0 INITIALIZE WINDS/CURRENTS/SURFACE ELEVATIONS

- 1 CREATE GRID AREA NAMES, KEY TO MAP
- 2 GET/LOAD STREAMFUNCTION GRID
- 3 GET LAT-LONG/VELOCITY FILE--LOAD GRID
- 4 SMOOTH GRID
- 5 ZERO GRID OVER LAND AND SHORELINES
- 6 PLOT GRID
- 7 SPECIFY LOCATION TO EVALUATE GRID FOR SUMMARY
- 8 SET MULTIPLICATIVE/ADDITIVE FACTOR FOR GRID AREA
- 9 DUMP A GRID TO DISK

10 AVERAGE NON-ZERO INTERSECTION OF TWO GRIDS TOGETHER
11 FIT MEASURED CURRENTS WITH GRIDS (LEAST-SQUARES)
12 DELETE GRID AREA

21 CREATE TIME FILE AREA NAMES
22 GET/LOAD TIME FILE
23 PLOT TIME FILE
24 SET MULTIPLICATIVE/ADDITIVE FACTOR FOR TIME FILE AREA
25 DUMP A TIME FILE AREA TO DISK
26 TAKE TIME DERIVATIVE OF TIME FILE AREA
27 CORRECT TIDAL COEFFICIENTS FOR TIME AND AMPLITUDE
28 DELETE TIME FILE AREA

40 JOIN/DISJOIN MAP TO TIME FILE AREA
41 JOIN/DISJOIN GRID AREA TO TIME FILE AREA

89 SUMMARIZE ALL ACTIVE INITIALIZATIONS

99 END WINDS/CURRENTS/SURFACE ELEVATIONS INITIALIZATION

0.3.1 CREATE GRID AREA NAMES, KEY TO MAP

The user is requested to assign a name to each grid to be used. Each grid name must be unique. Blanks are not acceptable. Each grid must be assigned to a map (therefore at least one map must already be initialized). The user is asked if this grid is a current grid. If it isn't, it is assumed to be a wind grid. All the default options are set. The grid name can be the same as the permanent file used to load it if the user desires. All references to the grid will be by grid name. The user may define up to twelve (12) different grid names for simultaneous use in OSSM.

0.3.2 GET/LOAD STREAMFUNCTION GRID

The user is requested to enter the name of the grid area to receive the data and the name of the permanent file which contains the data (see Data File Formats documentation). A streamfunction type file contains the 40 by 24 array of vectors for the grid (see SAC and DAC documentation.)

0.3.3 GET LONGITUDE-LATITUDE/VELOCITY FILE--LOAD GRID

The user is requested to enter the name of the grid area to receive the data and the name of the permanent file which contains the data (see Data File Formats documentation). A maximum of 960 entries are allowed in a Latitude-longitude/velocity file. Each grid box is loaded with the data entry that is located closest to its center.

0.3.4 SMOOTH GRID

This option is used to smooth a grid when the original data has very coarse resolution. The user is requested to enter the name of the grid area for which smoothing is desired. The center point is weighted .4, and the adjacent points .15. The weighting is adjusted along the edges and at the corners. It is sometimes desired to zero the grid over land and islands afterwards (Option 0.3.5) as smoothing can generate values over these regions. Smoothing the data is left to the user's discretion.

0.3.5 ZERO GRID OVER LAND AND SHORELINES

The user is requested to enter the name of the grid area for which zeroing is desired. The velocity vectors are zero only if every one of the four corresponding OSSM map coordinate boxes is not water.

0.3.6 PLOT GRID

The user is requested to enter the name of the grid area for which printer plotting is desired. The U and V components are plotted separately. The grid velocity values are normalized by the maximum speed. Positive velocities (east for U, north for V) are given numeric codes 1 through 9. Negative velocities are given alphabetical codes A through I. (For Calcomp plots of vectors see Option 0.10).

0.3.7 SPECIFY LOCATION TO EVALUATE GRID FOR SUMMARY

The default is that during a summary print, the grid will always be evaluated at the center of the OSSM map it is to which it is assigned. This option allows the user to specify the latitude and longitude for evaluation for any grid. The option also supplies information to the user on the magnitude of a multiplicative factor to make the velocity vector have unit magnitude at that location. This is helpful if the grid is a pattern to be keyed by measurements or data at the particular site.

0.3.8 SET MULTIPLICATIVE/ADDITIVE FACTOR FOR GRID AREA

Each grid has a multiplicative and additive factor. These factors can be used to scale the data, to turn velocity fields on and off at the discretion of the user, or to use different linear combinations of the velocity data. The multiplicative factor is given as A+i*B where

A=C*cos(d),
B=C*sin(d),
i=SQRT(-1.0),
C is the amplitude scaling or adjustment factor, and
d is the rotation angle, positive in the counterclockwise direction.

The default for currents is a multiplicative factor of 1.0 + i*0.0. The default value for winds is a multiplicative factor of 0.03+0.0*i and zero additive factor (3% of the wind and no turning angle). A user could specify a multiplicative factor of 0.03091 - 0.00828*i (3.2% of the wind and a turning angle of 15 degrees to the right).

The additive factor is given as U_o+i*V_o, where

U_o is a constant velocity added to the east-west component, and
V_o is a constant velocity added to the north-south component.

The default for currents and winds is 0+i0. Multiplicative and additive factors can be used also to set up a constant wind grid without loading any data.

0.3.9 DUMP A GRID TO DISK

This option is the reverse of Options 0.3.2 and 0.3.3. The user can request that a grid be dumped in either format (either as a block of vectors (0.3.2) or as a Latitude-longitude/velocity file (0.3.3)). In the second case, the user is requested to specify a coarseness factor. The data dump always begins at the upper left grid box. By specifying a coarseness factor greater than 1, the routine skips boxes. The number of boxes skipped in going across and down the grid is the coarseness factor. Maximum coarseness factor is 11, which dumps 12 entries (grid box rows 1, 12, and 23, and grid box columns 1, 12, 23 and 34). A coarseness factor of 1 dumps all 960 grid box entries.

0.3.10 ADD THE INTERSECTION OF TWO GRID AREAS TOGETHER

This option cross loads grid information between grids of different coverage and resolution. It can be used to load fine resolution to a coarser grid, and vice-versa. It avoids the lengthy computation of determining nearest data points. The user is requested to specify a receiving grid and a sending grid. In loading a high resolution grid to a coarse grid, there is an averaging effect to get a more representative value. The four spatial locations corresponding to the centers of the four OSSM map boxes covered by the receiving grid box are used to request velocity data from the sending grid. The non-zero values (if there are any) are averaged together. The velocity from the sending grid includes the multiplicative and additive factors. The grid value they are added to (receiving grid) does not include the effects of its own multiplicative and additive factors.

0.3.11 FIT MEASURED CURRENTS WITH GRIDS (LEAST-SQUARES)

This option does a least-squares fit between measured currents and any of the grids. If any of the grids are joined to time dependent files, the time dependence is included in the least-squares calculation. The user specifies the number of grids to fit the data and their names. The name of the data file containing the measurements is also required (see Data File Formats). The routine computes the cross covariance matrix, inverts it, and returns the regression coefficients (real only), and the measured, calculated, and residual vectors. Complex coefficients may be obtained by redefining the same grid and changing its multiplicative factor from real to imaginary. The regression coefficients multiply the existing multiplicative factors.

0.3.12 DELETE GRID AREA

This option allows the user to delete a grid area name and remove all the linkages it has to maps and time files, and zero all of its default parameters. Deleting a map (option 0.1.2) automatically invokes this routine for every grid assigned to the map.

0.3.21 CREATE TIME FILE AREA NAMES

The user is requested to assign a name to each time file area to be used. Each time file area name must be unique. Blanks are not acceptable. Time file names can be the same as the permanent file they reference, (or grids to which they are joined, or even the same as map names.) Six (6) time file areas are available. The user is requested to designate the time file area as a current, wind, or surface elevation area. Default parameters are set automatically.

0.3.22 GET/LOAD TIME FILE

The user is requested to enter the name of the time file area to receive the data and the name of the permanent file which contains the data (see Data File Formats documentation). The routine prints the first entry from the data file and then requests the user to specify a date and time to beginning loading data. The routine will skip all entries until it encounters one with the same date and time, or a greater date and time. Then it loads up to 100 entries into the specified area. If the user wants the time file area to begin at the first data point, a carriage return is sufficient. The user has the option of having the data listed. The start and end time relative to the model zero hour are printed. Out of sequence entries are noted, but it is the user's responsibility to correct them. Two entries with the same date and time will cause a zero divide and the model run will abort.

0.3.23 PLOT TIME FILE

The user is requested to enter the name of the time file area for which plotting is desired. The routine requests start and end dates and times for the plot. These can be different from the actual data coverage. The routine requests a time axis interval in hours (may be a fractional part). The plot is done vertically on the page, and each time axis interval will correspond to one print line. The data is interpolated with a Hermite cubic to generate data values at the specified times. The numeric values are printed to the side of the plot along with the integrated displacements. The maximum speed scales the plots of both U and V components. The U component is coded U, the V component is coded V. When both components have the same scaled value, the code is B. When the U and V components are both zero (or the time requested is out of the range of the data), a single period (.) is printed at the axis position.

0.3.24 SET MULTIPLICATIVE/ADDITIVE FACTOR FOR TIME FILE AREA

Each time file area has a multiplicative and additive factor. These factors can be used to scale the data, to turn velocity fields on and off at the discretion of the user, or to use different linear combinations of the velocity data. The multiplicative factor is given as A+i*B where

A=C*cos(d),
B=C*sin(d),
i=SQRT(-1.0),
C is the amplitude scaling or adjustment factor, and
d is the rotation angle, positive in the counterclockwise direction.

The default for currents and surface elevation is a multiplicative factor of 1.0 + i*0.0. The default value for winds is a multiplicative factor of 0.03+0.0*i and zero additive factor (3% of the wind and no turning angle). A user could specify a multiplicative factor of 0.03091 - 0.00828*i (3.2% of the wind and a turning angle of 15 degrees to the right).

The additive factor is given as U_o+i*V_o, where

U_o is a constant velocity added to the east-west component, and
V_o is a constant velocity added to the north-south component.

The default for currents, winds, and surface elevations is 0+i0. Multiplicative and additive factors can be used also to set up a constant wind time file area without loading any data.

0.3.25 DUMP A TIME FILE AREA TO DISK

This option dumps a time file area back to disk. No interpolation is done. The exact data points from the permanent file originally loaded to the time file area are restored to disk, after being recomputed with the effect of the additive and multiplicative factors included.

0.3.26 TAKE TIME DERIVATIVE OF TIME FILE AREA

This option takes the time derivative of a sending time file area and stores it in a receiving time file area. If the units on the sending time file are "units", the units on the receiving time file area are "units/hour". Since most data must be in meters/second, it is the user's responsibility to appropriately scale the derivative time file with the correct multiplicative factor (Option 0.3.24). The derivative is calculated by differencing adjacent values and dividing by the time elapsed between them. The value of the derivative is assigned to the midpoint in time between them. A derivate file always ends up with one less data point. The derivative time file area's multiplicative factor is set to 1.0+i*0.0, and additive factors set to 0.0+i0.0. The time file area type (wind, current, or surface elevation) is respecified to be the same as the sending time file area.

0.3.27 CORRECT TIDAL COEFFICIENTS FOR TIME AND AMPLITUDE

This option corrects a time file area (sending time file area) and stores it in a new time file area (receiving time file area). The original time file area is left untouched. The user is asked to enter the following six correction factors:

Correction to slack before ebb time (in hours and minutes),
Correction to ebb time (in hours and minutes),
Correction to slack before flood time (in hours and minutes),
Correction to flood time (in hours and minutes),
Multiplicative amplitude correction for flood,
Multiplicative amplitude correction for ebb.

The multiplicative factor of the sending time file area is temporarily reset to 1.0+i*0.0, and the additive factor 0.0+i*0.0. The correct factors are restored after the operation, and the receiving time file area is given the same factors.

0.3.28 DELETE TIME FILE AREA

This option allows the user to delete a time file area and remove all the linkages it has to maps and grid areas.

0.3.40 JOIN/DISJOIN MAP TO A TIME FILE AREA

Before a time file area contributes to the velocity field of any of the Lagrangian elements, it must first be joined to a map or grid. Joining a time file to a map means that every Lagrangian element on that map will have an identical component of velocity from the time file area. A time file area can be joined to several different maps at the same time. During a summary break, a listing of the joinings is printed for the user. The user is requested to specify the name of the time file area, and the map area, and whether to join or disjoin them.

0.3.41 JOIN/DISJOIN GRID AREA TO TIME FILE AREA

A time file area may also be joined to a grid area. The time file velocity and the grid area velocity are treated as complex quantities and multiplied together. The real part of the resulting product is the U component (east-west) and the imaginary part is the V component (north-south). In practice, usually one file contains amplitude information (real only), and the other file contains direction information which have a unit amplitude at some specified point in space. For some calculation and beaching algorithms, wind fields and current fields are considered distinct. Because both time file areas and grid areas are designated either currents or winds, the product of a grid area and a time file area is considered to be the same as the grid area.

0.3.89 SUMMARIZE ALL ACTIVE INITIALIZATIONS

This option summarizes everything initialized from Option 0.3. Because the time for evaluating time file areas is important, the user can set the current model time (Option 0.7.2.3). This option is also used during summary breaks to inform the user about active initializations.

0.3.99 END WIND/CURRENT INITIALIZATION

Return to Main Option.

0.4.0 INITIALIZE DIFFUSION AND SPREADING OPTIONS

The initialize diffusion and spreading overlay allows the user to model diffusion and spreading. One option is available. Option 0.4.1 solves the diffusion equation with a Monte Carlo technique (random walk) in which the horizontal step is constant.

The sequence response path codes and their associated sections are as follows:

0.4.0 INITIALIZE DIFFUSION AND SPREADING OPTIONS

1 DIFFUSION SIMULATED BY RANDOM WALK

99 END DIFFUSION AND SPREADING INITIALIZATION

0.4.1 DIFFUSION SIMULATED BY RANDOM WALK

The user specifies "N", the number of steps per hour, and "K_h", a horizontal eddy diffusivity constant in cm^2/sec. The routine computes the random walk step in kilometers/step as:

$$L = \left[K_h \left(\frac{cm^2}{sec}\right) * 3600 \left(\frac{sec}{hour}\right) / N \left(\frac{steps}{hour}\right) \right]^{\frac{1}{2}} / 10^5 \left(\frac{cm}{km}\right).$$

Suggested values for the horizontal eddy diffusivity and number of steps/hour are 10^5 cm^2/second and 1 respectively.

0.4.99 END DIFFUSION AND SPREADING INITIALIZATION

Return to Main Option.

0.5 INITIALIZE STATISTICAL WINDS

Initialize statistical winds is the overlay which allows the user to utilize wind histograms to generate climatological winds for running the model in a climatological mode. A separate statistical realization is generated for each Lagrangian element.

Appropriate inputs for these routines are usually wind histograms from climatic atlases, although local expertise can also be used (e.g. "70 % of the time the wind is from the north at 10-15 knots, 20 % of the time it is from the east at 5 to 10 knots, and 10 % of the time it is from the south at 20-25 knots for the month of June," would be a form of local expertise that would be appropriate for inclusion in these routines). Using histogram data, OSSM generates a simulation of it which is random, but has the same statistical distribution.

Option 0.5.1 formats the statistical wind data area for use for histograms. It also zeroes any histograms that may be present.

Option 0.5.2 loads a formatted histogram (see Data File Formats for description). Up to 12 separate histograms may be loaded at any given time.

Option 0.5.3 allows the user to delete individual histograms.

Option 0.5.4 allows the user to assign specific months of the year to specific histograms. A month may be assigned to only one histogram. A given histogram may be assigned to several months. For example, all the summer months could be assigned to the same histogram.

Option 0.5.5 prints a listing of what months are assigned to which histograms, and then allows the user to select a particular histogram for sample statistics. Both actual and simulated histograms will be printed.

Option 0.5.6 allows the user to set a complex multiplicative factor for all the histograms, to both scale them to appropriate units, and include 3% of the wind parameterizations and turning angle if this is desired. The user is referred to Option 0.3.8 for the use of multiplicative factors. Option 0.5.6 also allows the user to set the "duration" for the statistical winds. Duration is how long a realization of the statistical wind will persist before OSSM generates a new realization.

Option 0.5.7 allows the user to have histograms loaded in the model, but to turn them on or off when the model is actually run.

The sequence path response codes and their associated sections are as follows:

0.5.0 INITIALIZE STATISTICAL WINDS

1 INITIALIZE STATISTICAL WIND FOR HISTOGRAMS
2 LOAD A WIND HISTOGRAM

3 DELETE A WIND HISTOGRAM
4 SPECIFY VALID MONTHS FOR WIND HISTOGRAMS
5 SAMPLE STATISTICS FOR WIND HISTOGRAMS
6 SET MULTIPLICATIVE FACTOR AND DURATION
7 TURN STATISTICAL WINDS ON/OFF

99 END STATISTICAL WINDS INITIALIZATION

0.5.1 INITIALIZE STATISTICAL WIND FOR HISTOGRAMS

This option initializes the statistical wind data area for use by histograms. If any histograms are present, they are zeroed and cancelled. If this option is not entered, access to options 2 through 5 will not be granted.

0.5.2 LOAD A WIND HISTOGRAM

This option loads the preformatted wind histograms. Each histogram file must have a unique name up to seven letters long. The user is asked to enter the histogram file name. Duplicate names are not permitted. The wind histogram file consists of the speed intervals and the histogram values. The routine computes a cumulative probability distribution which is stored. The actual distribution can always be obtained by differencing the cumulative distribution.

0.5.3 DELETE A WIND HISTOGRAM

This option deletes a single histogram. The user is requested to furnish the same name as the histogram file. The histogram is deleted inside the model. The histogram file is not affected.

0.5.4 SPECIFY VALID MONTHS FOR WIND HISTOGRAMS

The user is requested to enter the name of the histogram file which has already been loaded, and then the month numerically (01=January, 02=February, etc.). If a month is not assigned to a histogram, then no statistical winds can be generated for that month.

0.5.5 SAMPLE STATISTICS FOR WIND HISTOGRAMS

This option prints a list of the 12 months and to which histogram, if any, they are assigned. The user is then asked to specify which month to sample, and how many times to sample it. Only months which are assigned to a histogram should be entered. The histogram should be sampled at least 1000 times to give a stable distribution. If "0" is entered as the number of times to sample, the routine is bypassed. The month to sample, and the number of times to sample are entered in free-field format.

0.5.6 SET MULTIPLICATIVE FACTOR AND DURATION

This option allows the user to set a complex multiplicative factor for all the histograms, to scale them to meters/sec and include the 3% wind parameterization of the surface currents. The user is referred to Option 0.3.8 for details on multiplicative factors. The default factor is 0.03+ i*0.0 (3 % of the wind speed, and no turning angle).

Duration is how long a realization of the statistical wind persists before a new realization is calculated. Whereas this is an obvious choice for first order transition matrices for climatological winds (six hour transition matrix, twelve hour transition matrix, twenty-four hour transition matrix, etc.), it is not an obvious choice for wind histograms. Acceptable values range between twelve and seventy-two hours. The default value is twenty-four hours. If the user selects a small value, say one hour, then the trajectory or receptor mode run sees an average wind, which is just the average wind for the histogram. Long duration increases the variance in the distribution of the Lagrangian elements, while short duration decreases the variance.

0.5.7 TURN STATISTICAL WINDS ON/OFF

The user is asked if it is desired to set the statistical winds on. The response is yes or no. The statistical winds are turned on automatically if the initialization option (0.5.1) is entered. This option should only be used to turn off statistical wind histograms that are already loaded.

0.5.99 END STATISTICAL WINDS INITIALIZATION

Return to Main Option.

0.6.0 INITIALIZE USER ROUTINES

This option allows the user to insert specialized routines without disrupting the rest of OSSM. Further expansion of the program is envisioned. Time-dependent velocity patterns from numerical circulation models; keying velocity patterns in a Monte Carlo fashion to simulate regional wind patterns; damage assessment based on the data bases already in use and proposed data bases; and estimation of clean-up costs for a given sill are just some of the areas for which code is being designed. Eventually new routines will be placed in the appropriate overlays or new overlays will be created. A user should write his or her own "menu" to facilitate entry and exit from this section. It is suggested that the user adhere to the following conventions:

A carriage routine should always be answered with appropriate information; "89" should always yield information about what has been initialized; "99" should always be used to exit an option.

The sequence response path codes and their associated sections are as follows:

0.6.0 INITIALIZE USER ROUTINES

99 END USER ROUTINES INITIALIZATION

0.6.99 END USER ROUTINES INITIALIZATION

Return to Main Option.

0.7 TRAJECTORY RUNS AND CONCENTRATION MAPS

The trajectory runs and concentration maps overlay directly controls running the trajectory model. All run parameters such as model start time, end time, time step interval, current model time, time of next map, time between maps, etc., are set in this section. There are preset defaults for all these parameters which are not very useful. They are set to insure that the program does not unexpectedly terminate because of unspecified parameters. It is always appropriate for the user to specify the run parameters. In allowing run parameters to be reset, the user can execute several distinct scenarios in the same job run.

Additionally, the user can request data summaries with each map, duplicate listing of maps and data summaries stored in a disk file, suppression of maps printed at the terminal, maps by pollutant type options, as well as receptor mode models for travel time contours and spatial probability distributions.

The sequence path response codes and their associated sections are as follows:

0.7.0 TRAJECTORY RUNS AND CONCENTRATION MAPS

1 RUN WITH SET PARAMETERS
2 RESET ZERO HOUR
3 RESET CURRENT MODEL TIME
4 AUTOMATIC INCREMENT TO START AND END TIMES
5 SET START TIME, END TIME, TIME STEP INCREMENT
6 SET TIME OF NEXT MAP, TIME STEP BETWEEN MAPS
7 PRINT A SUMMARY WITH EACH MAP
8 DUPLICATE LISTING ON TAPE6
9 SUPPRESS MAPS AND SUMMARIES BEING PRINTED AT TERMINAL DURING RUNNING
10 MAPS BY POLLUTANT TYPE OPTIONS
11 RECEPTOR MODE MAPPINGS

0.7.11 RECEPTOR MODE MAPPINGS

1 TIME CONTOURS
2 PROBABILITY DISTRIBUTION

99 EXIT RECEPTOR MODE MAPPINGS ROUTINES

89 SUMMARIZE RUN OPTIONS

99 EXIT TRAJECTORY RUNS AND CONCENTRATION MAPS ROUTINES

0.7.1 RUN WITH SET PARAMETERS

This option actually calculates the trajectories and uses the data that the user has specified in all the other initialization options. It controls the printing of maps and summary print breaks. If the current time is later than the start time, the current model time becomes the start time. If the current time is greater or equal to the end time, all running is bypassed. If the model time step is zero, all running is bypassed. If the difference between start and end time is not an integer multiple of the model time step, the end time is increased to the next highest integer multiple. Each trajectory has its position updated and its status checked at each time step. It is usually appropriate to execute option 0.8.3 (write checkpoint file to disk) immediately before this option is executed. This will give the user the opportunity to interrupt the model, and reinitialize parameters by reloading the checkpoint and making the appropriate initialization changes.

0.7.2 RESET ZERO HOUR

This routine allows the user to reset the zero hour and date that was originally initialized at the beginning of OSSM.

0.7.3 RESET CURRENT MODEL TIME

The user is requested to enter the day, month, year, hour, and minute of the current time desired. Whenever a map is printed during a trajectory run, or a summary is being printed, it is always done at current model time. If the user desires a different model time, this option is used to set it. The user should be careful to print a trajectory map only at a current model time that reflects their actual history.

This option can be useful in the following instance: A tanker developed a leak and travelled over a specified course. Using option 0.2.2, Lagrangian elements can be distributed along the specified course at the specified time. Setting the current model time to the time of last position will allow the path of the tanker to be plotted.

The current model time is updated by option 0.7.1 and equals the end time at the end of a run.

0.7.4 AUTOMATIC INCREMENT TO START AND END TIMES

This option automatically increments the start and end times so a run can be extended. The start and end times are both incremented by the number of hours difference between them. Leap years and end of months are automatically handled. The new start and end times are printed for the user. This option is useful when the user desires to run the model in time spans of a set amount.

0.7.5 SET START TIME, END TIME, TIME STEP INCREMENT

This option governs the start and end time of the model run, and the model time step. Selection of the model time step is the responsibility of the user. In calculating the displacement of each Lagrangian element, it multiplies the velocity data. It has no effect on the number of diffusion steps (option 0.4.1).

On coarse resolution maps (such as a map of the entire Gulf of Mexico) a time step of 12 to 24 hours is appropriate. On a smaller map, a time step on the order of an hour, or some fraction of an hour is appropriate. A useful rule of thumb is that the time step in hours should roughly equal the size of an OSSM grid box in kilometers. This will usually be sufficient to prevent a Lagrangian element from traversing an entire OSSM grid box (assuming a maximum velocity of 35 cm/s). The user is requested to specify the start and end times as day, month, year, hour, and minutes (each as a two digit number). The model time step increment is entered in hours (or hours and a fraction of hours).

0.7.6 SET TIME OF NEXT MAP, TIME STEP BETWEEN MAPS

This option allows the user to specify for what date and time the first map should be printed, and how often thereafter a map should be printed. The date for the first map can be outside the range of the trajectory run if no map is desired. Every time a set of maps is printed, the time of the next map is automatically updated.

0.7.7 PRINT A SUMMARY WITH EACH MAP

This option can be turned on or off as the user desires. When the maps are printed, this option controls the summary print break. A summary of all parameters initialized will be printed. It takes approximately a page to print, and is usually worth having in order to know what the data bases were. The output is identical with option 0.8.1 (list all initialized parameters).

0.7.8 DUPLICATE LISTING ON TAPE6

If the user desires, a duplicate copy of all trajectory maps, receptor mode runs, and summary print breaks (and all summaries from any section) will be made on TAPE6. TAPE6 is an indirect file, and at the end of the run, it should be replaced (see NOS Control System). This option is useful for saving the printer output so it can be listed at a different site. The user can also edit the TAPE6 file to include caveats and explanations.

0.7.9 SUPPRESS MAPS AND SUMMARIES BEING PRINTED AT TERMINAL DURING RUNNING

This option allows the user to suppress all printing of maps while the model is running. If option 0.7.8 (duplicate listing on TAPE 6) has been turned on, the maps will still be available on TAPE6 for later perusal and post-processing. This option also suppresses the printing of receptor mode maps.

0.7.10 MAPS BY POLLUTANT TYPE OPTIONS

This set of options allows the user to specify what types of maps are desired when a map-break (time to print another map) is reached. There are 13 different types of maps the user can request. They are printed sequentially, beginning with the lowest control codes. To request each type of map, the user is asked to enter a map control code and switch setting (on/off). The map control codes are as follows:

0 Print map(s) with none of the Lagrangian element information.

1 Print the default map(s) (all Lagrangian elements are included, regardless of pollutant type.

2 Print the map(s) and include all Lagrangian elements and include even the evaporated (decayed or empirically accomodated) elements. Even if an element has been removed by evaporation, the model continues to update its position, and hence at map time, it is possible for every Lagrangian element to be treated as a conservative substance, regardless of what was specified when it was initialized.

(3+pollutant type) (map codes 4 through 13)
Print the map and include only the Lagrangian elements of a specified type:

4 Gasoline only;
5 Kerosene and jet fuel only;
6 Diesel only;
7 No. 4 only;
8 Medium crude only;
9 No. 6 only;
10 User definable substance one only;
11 User definable substance two only;
12 Conservative substance only;
13 Default substance only.

89 Reset control codes to default values (default map only--map code 1).

99 Exit option.

The switch settings are as follows:

-1 Turns option off;
+1 Turns option on.

For options 89 and 99, a switch setting must be entered, although it is not used. Additionally, the use should refer to Option 0.1.4 because that option controls which maps will be printed. This option controls what type of map will be printed. If no Lagrangian elements are active for a particular type of map, or none have been initialized, the map will not be printed.

0.7.11 RECEPTOR MODE MAPPINGS

The "receptor mode" is a specialized form of the trajectory model. It answers the following questions:

> Given a receptor or potentially high value impact site, what percent of a spill occurring anywhere else will reach the receptor site.
>
> How long will it take for a spill occuring anywhere else to reach the receptor site?

One way to compute the answer would be to simulate spills in each OSSM grid box, using Lagrangian elements, and recording the percentage of them that reach, or pass through, the receptor site, and the arrival time of the first one getting there. However, this would involve a great many separate trajectory runs.

There is a simpler way to get this answer. In computing the receptor mode, the trajectory model is run in reverse (both space and time) for all advection data (current and wind fields), and forward in time for diffusion and evaporation. All boundaries are assumed to be reflective--there is no beaching of oil. It can easily be shown that the percent of the Lagrangian elements leaving the receptor site and passing through a particular OSSM grid box is equal to the same percentage of trajectories that would leave the given OSSM grid box and impact the receptor site in a normal forward trajectory calculation. Consider the following three processes acting independently of each other: 1) advection, 2) diffusion, and 3) evaporation.

Case 1. Only advection is considered. The path between a given site and a receptor site can be traced both forwards and backwards with data that is spatially and temporally keyed. If the advection data is statistical, then it can be treated as a form of diffusion.

Case 2. Only diffusion is considered. The Monte Carlo solution for the diffusion equation with constant coefficients converges to the actual solution for reflective boundaries (no beaching) (Csanady, 1973). It is worthwhile to consider the effect of absorbing and refloating boundaries on the diffusion equation. Consider a long channel with a receptor site at the far closed end. Any spilled oil entering the channel will have a neglible probability of reaching the receptor site because it is more likely to be beached on the sides of the channel. Multiple beachings of the same oil, even with partial refloating would have the effect of limiting the potential threat zone to the immediate vicinity of the mouth of the channel. Hence, it is appropriate to calculate the receptor modes with "sticky" boundaries as well was reflective boundaries.

Case 3. Only evaporation is considered. Evaporation processes in OSSM are identical for a specified substance, regardless of the location on the map. Only the exposure history is considered.

The potential threat zone contours are different for a spill of medium crude oils and gasoline. Because of the high evaporation rate for gasoline, five day travel time contours for a gasoline spill are non-existent, whereas three week or longer travel time contours for medium crude oils are reasonable.

Since evaporation is substance specific, receptor mode maps for a specific site will be different for different substances. Two separate receptor mode maps can be requested: time contour and probability contour receptor mode maps. Time contour receptor mode maps specify the travel time to a receptor site for spills occuring elsewhere in the model. Probability contour receptor mode maps specify the probability that spills happening at any particular location on the OSSM map will reach the receptor site.

The OSSM data base set up is virtually identical for receptor mode map trajectories and standard trajectory runs. The user initializes maps, currents and winds, diffusion, statistical winds, and run parameters in the usual way. The only difference in data base setup is given as follows:

Lagrangian elements (option 0.2) are given the receptor site for their location. A receptor site is usually taken to be a single OSSM grid box, and therefore option 0.2.4 is the appropriate initialization option to use. A receptor site can be taken to be several OSSM grid boxes, but the calculated answer will have a different meaning: the time contours will have the correct meaning, but the probability contours will not be correct. If the user wants probability contours, multiple receptor sites should never be specified in a single run. The start and end times for model running (option 0.7.4) are used to run the model backwards. Lagrangian elements are stopped when their start time expires.

Listed below are the sequence response path codes and their associated sections:

0.7.11 RECEPTOR MODE MAPPINGS

- 1 TIME CONTOURS
- 2 PROBABILITY DISTRIBUTION

- 99 EXIT RECEPTOR MODE MAPPINGS ROUTINES

0.7.11.1 TIME CONTOURS

The user enters the number of contours desired and the number of times to replicate each Lagrangian element. If no random processes (diffusion or statistical winds) are initialized the number of times to replicate each Lagrangian element should be one. The purpose of replicating an individual Lagrangian element is to provide a large number of them to ensure smooth contours. There is essentially no difference between starting with 10 Lagrangian elements at the receptor site and replicating them 10 times and starting with 100 Lagrangian elements and replicating them once. The user can do it either way.

This is the contouring rational: an individual Lagrangian element is moved around and at each time step, the OSSM grid box it is in is assigned the the current time contour value if a time contour value has not yet been specified for this grid location, or if the current time contour value is smaller then the time contour value already assigned at this location. In this way the largest area appropriate for the low values contours is delineated. It may be that a ten day and a one day travel time contour actually occupy the same location (existence of offshore eddies). In terms of threat to a receptor site, the one day contour is the appropriate choice.

0.7.11.2 PROBABILITY DISTRIBUTION

The user enters the number of times to replicate each Lagrangian element (see the above section on time contours).

This is the contouring rational: an individual Lagrangian element is move around and each grid location that it passes through is flagged only once. At the end of the run for each Lagrangian element, the locations flagged are summed to a grid accumulator for each map, and the flags are reset to zero for the next Lagrangian element. In this way, a location does not get a high probability value if a single Lagrangian element passes through it on more than one occasion.

0.7.11.99 EXIT RECEPTOR MODE MAPPINGS ROUTINES

Return to Trajectory Runs and Concentration Maps.

0.7.89 SUMMARIZE RUN OPTIONS

This option prints a summary of the run parameters. It is usually worthwhile to list them and verify them before option 0.7.1 is executed. This routine is also part of the summary print break.

0.7.99 EXIT TRAJECTORY RUNS AND CONCENTRATION MAPS ROUTINES

Return to Main Option.

Figure 12. Daily travel time contours for hypothetical receptor sites.

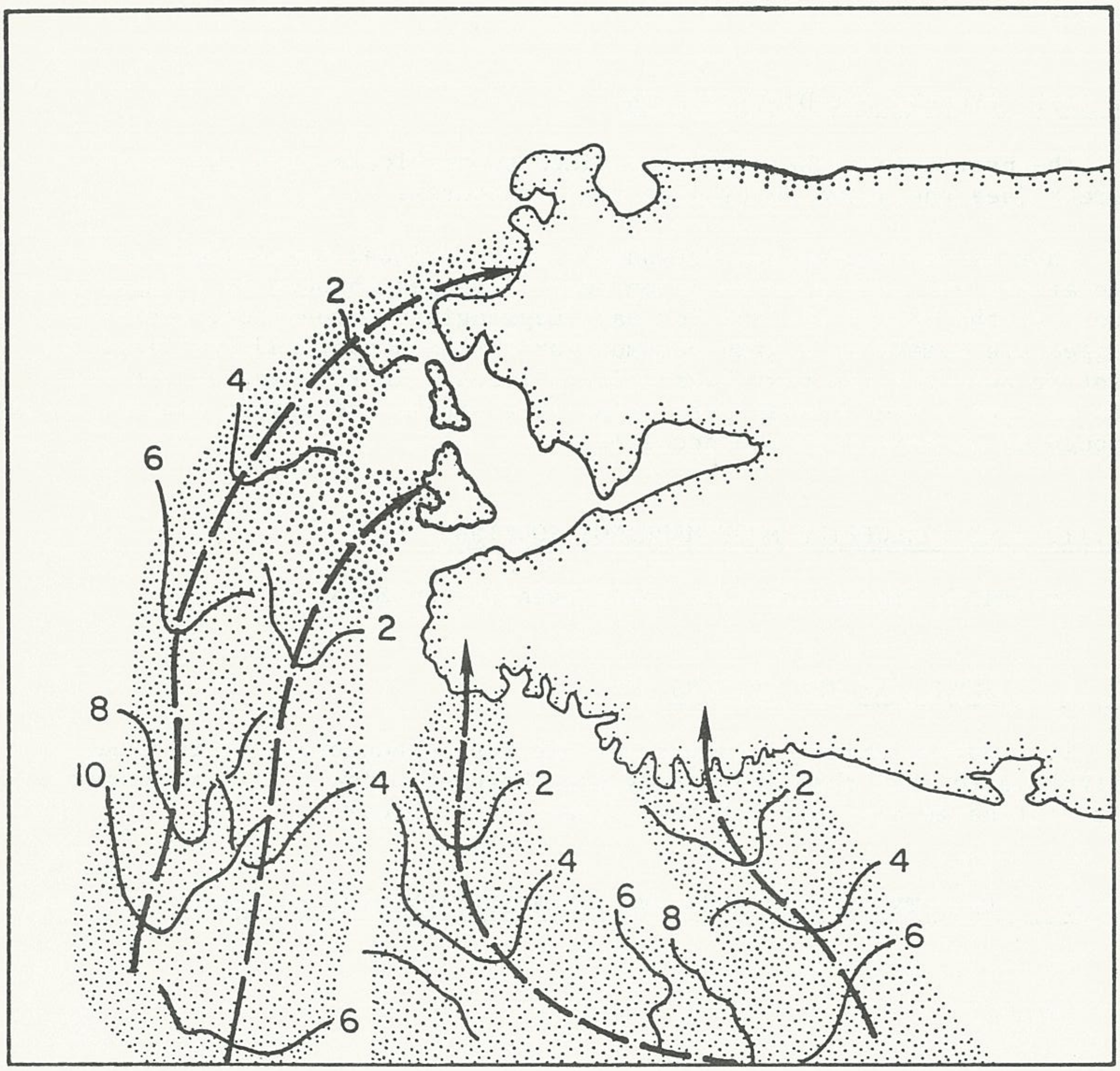
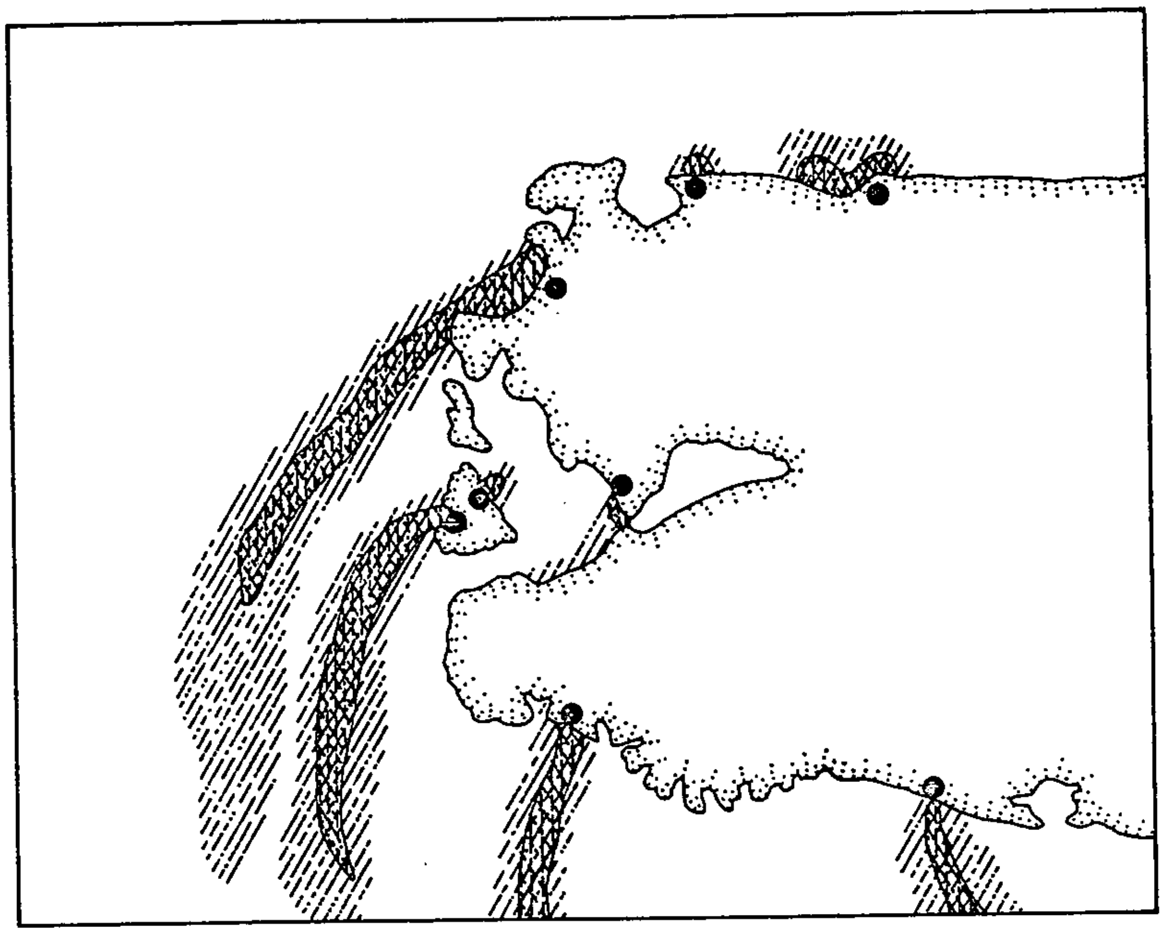


Figure 13. Probability density distribution for hypothetical receptor sites.



0.8 LIST/READ/SAVE INITIALIZATION

The list/read/save initialization overlay allows the user to print a summary break at any time, and to write and read initialization or checkpoint files. An inadvertant miskeying could be disastrous. For example, if one wanted to read a file and entered the save command mistakenly, the file meant to be read would be destroyed; if one wanted to save an initialization and entered the read command mistakenly, the initialization would be destroyed. Therefore, this is the only section of the program that is not keyed by numbers, but by actual English words. The well founded reason for this difference in keying strategy is that a mistake in this section can be onerous to rectify or mitigate.

The summary print break is used to inform the user of the contents of a checkpoint files. Checkpoints can be used to save an initialization, a simulation, or a set of results. The English words and their associated sections are as follows:

0.8.0 LIST/READ/SAVE INITIALIZATION

LIST LIST ALL INITIALIZED PARAMETERS
READ READ INITIALIZATION FILE FROM DISK (NEW FORMAT SEPT, 82)
SAVE SAVE INITIALIZATION FILE ONTO DISK (NEW FORMAT SEPT,82)

99 EXIT LIST/READ/SAVE INITIALIZATION ROUTINES

0.8.LIST LIST ALL INITIALIZED PARAMETERS

This option causes a summary print break. It prints out all of the summary routines for all the initialization sections.

0.8.READ READ INITIALIZATION FILE FROM DISK (NEW FORMAT SEPT, 82)

This option reads an initialization file from disk and reinitializes all system parameters, maps, options, etc. The user must supply the name of the direct file containing the initialization. The format for the initialization is an internal format, and therefore not described in the Data File Formats documentation.

0.8.SAVE SAVE INITIALIZATION FILE ONTO DISK (NEW FORMAT SEPT, 82)

This option writes an initialization file to disk. The user must supply a name for the initialization file. If any other file in the user's area has the same name, it will be destroyed and a new file will take its place.

0.8.99 EXIT LIST/READ/SAVE INITIALIZATION ROUTINES

Return to Main Option.

0.9 LOCATE GEOGRAPHICAL POSITIONS

The locate geographical positions overlay allows the user to convert from latitude and longitude to OSSM map coordinates and back again. The latitude and longitude of an OSSM grid box is taken to be its center.

The sequence path response codes and their associated sections are as follows:

0.9.0 LOCATE GEOGRAPHICAL POSITIONS

1 ENTER LATITUDE, LONGITUDE
2 ENTER MAP NAME, I, J

99 EXIT LOCATE GEOGRAPHICAL POSITIONS ROUTINES

0.9.1 ENTER LATITUDE, LONGITUDE

The user enters degrees latitude, minutes latitude, degrees longitude, and minutes longitude. All maps are checked and OSSM coordinates are given for each map on which the latitude and longitude are found.

To exit the option, the user enters 99,9,9,9.

0.9.2 ENTER MAP NAME, I, J

The user is requested to enter the map name. Then the user is requested to enter the I and J coordinate of the OSSM grid box of interest. For an OSSM map I is the column and J is the row. The upper left hand corner is I,J=1,1. The lower right hand corner is I,J= 80,48. Hence the numbers for the grid boxes increase toward the right hand side of the map and towards the bottom of the map.

The user enters 99,9 to terminate entering additional I,J pairs for a particular map. The output is the latitude and longitude of the center of the OSSM grid box designated by its I and J coordinates for the particular map.

0.9.99 EXIT LOCATE GEOGRAPHICAL POSITIONS ROUTINES

Return to Main Option.

0.10 CALCOMP PLOTTING

The calcomp plotting overlay allows the user to generate report quality graphics. "Calcomp" plotting is associated with line drawings of data presentations. The options in this overlay use the calcomp subroutines to generate a tape of plot commands which is post-processed to generate images for a particular plotting device. We utilize a local grown utility program named "Showme" which is a calcomp post-processor for generating cathode ray tube (CRT) displayed plots on the Tektronix* 4051 terminal and drawing them on a Tektronix* 4662 interactive digital plotter.

All plots are done with a plotting area 9.75 by 9.75 inches (24.765 by 24.765 cm.). The calcomp software generates the plot commands in inches, not centimeters. International standards will probably require a "fix" to convert the plotting lengths to centimeters. The conversion is that 2.54 centimeters equals 1.0 inch exactly, for those who are not used to this measurement standard.

The border of the plots is 8 inches (20.32 cm.) by 8 inches with an additional .875 inch (2.2225 cm.) border for labels see Figure 7. All labels have been designed not to overlap each other. Specific exceptions are noted.

The plot options have been divided into six basic areas:

(1) STANDARD TASKS,
(2) LAND MAP AND TRAJECTORIES,
(3) ANNOTATE,
(4) VELOCITY VECTORS,
(5) DAC AND SAC PLOTS, and
(6) MISCELLANEOUS.

"Standard tasks" include opening and closing the plot file, specifying a map for plotting purposes, setting the bounding latitudes and longitudes for a plot, and doing a standardized trajectory plot. Until the plot file has been opened and a map specified for plotting purposes, access to options 0.10.11 thru 0.10.60 will not be granted.

"Land map and trajectories" draws map outlines, coastal outlines, shades the land areas or writes the beaching codes, plots the trajectories on the map and advances to a new plot surface for the next plot.

"Annotate" does standardized plot annotations for trajectory plots, such as drawing and annotating the map scale, latitude and longitude lines and the map corners. It allows for special annotation of the top border and bottom border of the plot (three lines each). It will also draw a legend for the shoreline descriptors in use for this plot.

"Velocity vectors" does the plotting of grid area velocity files, sum of all grid area velocity files, latitude-longitude/velocity files, time dependent amplitude and velocity files, and velocity arrow scales for the grid area plots.

*Tektronix, a registered trademark.

"DAC and SAC plots" includes reading and storing the vertex and boundary data, the triangle data for the Finite Element formulations, and the streamfunction data with values of the streamfunction, amplitude factors, or surface elevation at each vertex. The vertices, boundaries, and triangles can all be plotted. The vertices, triangles, depths and DAC or SAC values can be labeled. The depth and DAC or SAC values can be contoured as well.

"Miscellaneous" contains but a single option, and that is for enlarging or shrinking the plot.

Figure 8 is a plot example which has been annotated with the options used to produce it.

The user can specify global boundaries for the plot area. Without global boundaries, the plot boundaries are assumed to be the same as the map defining the plot region (Option 0.10.4). If the user specifies global boundaries, the global boundaries become the sides of the 8 inch square plot surface. The current map being plotted is considered "local" and is located relative to the "global boundaries." In Figure 6, the map for the entire Gulf of Mexico was used to define the global boundaries, and the individual maps for the northeast Gulf of Mexico, and Brownsville, Corpus Christi, and Galveston regions were in turn local maps. The global specification allows adjoining and embedded maps to be correctly plotted relative to each other. If a local map exceeds the global boundaries, then the local map's boundaries define the entire plot area.

The sequence path response codes and their associated sections are as follows:

0.10.0 CALCOMP PLOTTING

<u>STANDARD TASKS</u>

1 OPEN PLOT FILE
2 GLOBAL BOUNDARIES DESIRED
3 CLOSE PLOT FILE
4 GET A PARTICULAR MAP FOR PLOTTING
5 STANDARDIZED TRAJECTORY PLOT

99 EXIT CALCOMP PLOTTING ROUTINES

<u>LAND MAP AND TRAJECTORIES</u>

11 DRAW GLOBAL BOX
12 DRAW LOCAL BOX
13 DRAW COASTAL OUTLINES
14 HASH FILL NON-WATER AREAS
15 PLOT SHORELINE DESCRIPTORS
16 PLOT TRAJECTORIES
17 ADVANCE TO NEW PLOT SURFACE

ANNOTATE

21 STANDARD ANNOTATION FOR TRAJECTORIES
22 ANNOTATE TOP THREE LINES
23 ANNOTATE BOTTOM THREE LINES
24 DRAW SCALE AND ANNOTATE
25 DRAW LAT/LONG LINES AT INCREMENTS OF D1, ANNOTATE AT INCREMENTS OF D2
26 ANNOTATE LAT/LONG CORNERS OF PLOT
27 ANNOTATE SHORELINE DESCRIPTORS (LEGEND)

VELOCITY VECTORS

31 PLOT GRID AREA VECTORS FOR THIS MAP
32 PLOT SUM OF ALL VECTORS FOR THIS MAP
33 PLOT A LAT/LONG-VELOCITY FILE WITH THIS MAP
34 PLOT A TIME-DEPENDENT FILE (AMPLITUDE OR VECTOR)
35 DRAW VELOCITY ARROW SCALE FOR GRID VECTOR PLOTS

DAC AND SAC PLOTS

41 GET VERTEX AND BOUNDARY DATA
42 GET TRIANGLE DATA
43 GET STREAMFUNCTION DATA
44 PLOT VERTICES
45 PLOT BOUNDARIES
46 PLOT TRIANGLES
47 LABLE VERTICES
48 LABLE TRIANGLES
49 DRAW DEPTH CONTOURS
50 LABLE DEPTHS
51 DRAW SAC/DAC CONTOURS
52 LABLE SAC/DAC VALUES

MISCELLANEOUS

60 CALCOMP ENLARGE/SHRINK PLOT

99 EXIT CALCOMP PLOTTING ROUTINES

STANDARD TASKS

0.10.1 OPEN PLOT FILE

This option opens the calcomp plot file. All plot instructions are written to logical unit TAPE99. Access to the other options will not be granted until the plot file is opened. The plot file should be opened only once in an OSSM run.

0.10.2 GLOBAL BOUNDARIES DESIRED

The user can specify "global boundaries" for the plot area. Without "global boundaries", the plot boundaries are assigned the bounding latitudes and longitudes of the particular plotting reference map (Option 0.10.4). If the user chooses to specify "global boundaries" the plot boundaries are assigned the bounding latitudes and longitudes of the "global boundaries". The current map being plotted or used for plotting reference is considered "local" and is positioned relative to the "global boundaries." In Figure 6, the map for the entire Gulf of Mexico was used to define the "global boundaries" and the individual maps for the northeast Gulf of Mexico, Brownsville, Corpus Christi, and Galveston regions were in turn "local" maps. Any map distortion in the "global boundaries" will cause a distortion in the "local" maps being plotted. The "global" specification allows adjoining and embedded maps to be correctly plotted relative to each other. If a "local" map exceeds the "global boundaries, then the "local" map's boundaries define the plot area. A "global boundary" specification remains active until it is cancelled. The user is asked if "global boundaries" are desired. A "no" response causes "global boundaries" to be cancelled. If "global boundaries" are desired, the user is requested to enter the following data items:

Degrees and minutes latitude on the north side for the map,
Degrees and minutes latitude on the south side for the map,
Degrees and minutes longitude on the west side for the map,
Degrees and minutes longitude on the east side for the map.

0.10.3 CLOSE PLOT FILE

This option writes the appropriate calcomp instructions at the end of the plot file and closes it. Failure to close the plot file may result in errors for the post-processor. The calcomp file should not be reopened. If additional plots are required after the plot file has been closed, the user should terminate OSSM, save the plot file under a name different than TAPE99, and begin a new session with OSSM.

0.10.4 GET A PARTICULAR MAP FOR PLOTTING

A particular map must be referenced in order to do any plotting. The user is required to enter a valid map name. The map is checked against global boundaries if they are being used, and if the map exceeds the global boundaries, then the global boundaries will be overridden. Options 0.10.2 and 0.10.4 both check to see if global boundaries will be overridden by local boundaries; the sequence of executing these options makes no difference. For spatial plots, only data inside a local maps boundaries will be plotted.

0.10.5 STANDARDIZED TRAJECTORY PLOT

The standardized trajectory plot option automatically calls the following sequence path response codes:

0.10.4 GET A PARTICULAR MAP FOR PLOTTING
0.10.12 DRAW LOCAL BOX
0.10.13 DRAW COASTAL OUTLINES
0.10.15 PLOT TRAJECTORIES
0.10.21 STANDARD ANNOTATION FOR TRAJECTORIES
0.10.26 DRAW SCALE AND ANNOTATE
0.10.28 ANNOTATE LONG/LAT CORNERS OF PLOT
0.10.16 ADVANCE TO NEW PLOT SURFACE.

If more elaborate plotting is required, then the user should not use this option. Figure 9 is an example of a standardized trajectory plot.

0.10.99 EXIT CALCOMP PLOTTING ROUTINES

Return to Main Option.

LAND MAP AND TRAJECTORIES

0.10.11 DRAW GLOBAL BOX

If global boundaries have been initialized, then this option will draw the 8 inch (20.32 cm.) square box which encloses the area defined by the global boundaries. If there are no global boundaries, the option is bypassed.

0.10.12 DRAW LOCAL BOX

This option draws the box representing the local map's boundaries. If there are no global boundaries, then the local box is the 8 inch (20.32 cm.) square box. Otherwise, it is some smaller box inside the global boundaries.

0.10.13 DRAW COASTAL OUTLINES

This option draws the coastal outline of the local map. It also draws the outline of areas with shoreline descriptors.

0.10.14 HASH FILL LAND AND ISLANDS

This option shades the land and shoreline descriptor areas with disconnected vertical lines, and shades the water areas cross-referenced to shoreline descriptors (e.g. marsh and tidal flat areas) with disconnected diagonal lines. Figure 10 shows hash filling.

0.10.15 PLOT SHORELINE DESCRIPTORS

This option writes shoreline descriptor codes for each location on the OSSM map. This option should be used in conjunction with option 0.10.27 which draws a legend for the shoreline descriptors in use for this map.

0.10.16 PLOT TRAJECTORIES

This option plots the positions of each Lagrangian element if the current model time is greater than its release date. Lagrangian elements in the water are plotted as small circles. Lagrangian elements that are beached are plotted as small plus signs.

0.10.17 ADVANCE TO NEW PLOT SURFACE

This option places 10 equally spaced dots at the top of the plot area. Then the plot area is advanced to a new plot surface for plots routed to a calcomp device. This option causes the CRT viewing screen to blank.

ANNOTATE

0.10.21 STANDARD ANNOTATION FOR TRAJECTORIES

This option annotates the top two lines of the plot with the map title and the current model date and time. If this option is used, then Option 0.10.22 should only be used to annotate the third line.

0.10.22 ANNOTATE TOP THREE LINES

The user can manually annotate the top three lines above the plot. The user is requested to enter each line (up to 80 characters per line). After the third line is entered, the routine will print out the three lines and ask the user if they are correct. A "no" response will cause the routine to be bypassed. A "yes" response will cause them to be written to the plot file. If the user is also going to use Option 0.10.21 on this plot surface, the user should check to make certain that the two annotations do not write on top of each other.

0.10.23 ANNOTATE BOTTOM THREE LINES

The user can manually annotate the bottom three lines below the plot. The user is requested to enter each line (up to 80 characters per line). After the third line is entered, the routine will print out the three lines and ask the user if they are correct. A "no" response will cause the routine to be bypassed. A "yes" response will cause them to be written to the plot file.

0.10.24 DRAW SCALE AND ANNOTATE

The scale is always drawn below the plot at the lower left. It is either the scale of the lower latitude of the global boundaries or the local boundaries if global boundaries are not used, or if they have been overridden. The number of digits to the right of the decimal point is a function of the size scale. The length of the scale is always one inch.

0.10.25 DRAW LAT/LONG LINES AT INCREMENTS OF D1, ANNOTATE AT INCREMENTS OF D2

The user can draw the latitude and longitude lines on either the global map (if it exists and has not been overridden by the local map) or the local map. The user is requested to supply "D1" and "D2". "D1" is the number of integer minutes to space latitude and longitude lines. Entering 60 would cause a line for every whole degree. The lines always commence at a whole degree. For example, if the edge of of the plot was at 17 degrees 47 minutes, and the user specified lines every 5 minutes, the plot would have lines drawn at 17 degrees 50 minutes, the next one at 17 degrees 55 minutes, and so forth. "D2" is how often to annotate the lines. A "0" results in no annotation. A "1" causes every one to be annotated. A "2" causes every other one to be annotated and so forth.

0.10.26 ANNOTATE LAT/LONG CORNERS OF PLOT

This option annotates the upper left and lower right corner of the plot with latitude and longitude for the global map. If there is no global map or if it is overridden, then the local map will be annotated instead. Use of this option does not cause any labeling conflict with other annotation options.

0.10.27 ANNOTATE SHORELINE DESCRIPTORS (LEGEND)

This option draws a legend inside the plot border which contains the shoreline descriptors in use for this map, the alphabetic code used in option 0.10.15 to label the map, and the vulnerability index of each shoreline descriptor. Since this annotation is inside the plot border, it is usually appropriate to advance to a new plot surface both before and after using this option.

VELOCITY VECTORS

0.10.31 PLOT GRID AREA VECTORS FOR THIS MAP

This option plots the grid vectors of a particular grid file. If the grid is not assigned to the local map, the routine is bypassed. The user should usually perform option 0.3.5 (zero grid over land and shorelines) before using this option. Vectors will be zeroed for current grids if they lie entirely over land areas for plotting purposes. Vectors whose magnitude is less than .01 m/sec are not plotted.

0.10.32 PLOT SUM OF ALL VECTORS FOR THIS MAP

This option plots the sum of all grid areas and time file areas assigned or joined to a given map. The user can request just currents, or just winds, or the sum of both. The vectors are calculated for the current time. The time step increment, option 0.7.5 must be nonzero. Vectors smaller than .01 m/s are not plotted.

0.10.33 PLOT A LAT/LONG-VELOCITY FILE WITH THIS MAP

This option allows the user to plot the contents of a latitude/longitude velocity file. The user is asked to enter a real multiplying factor to scale the data. Usually 1.0 is appropriate. Only vectors whose origin is inside the local map will be plotted. Vectors whose magnitude is smaller than .01 m/s are not plotted.

0.10.34 PLOT A TIME DEPENDENT FILE (AMPLITUDE OR VECTOR)

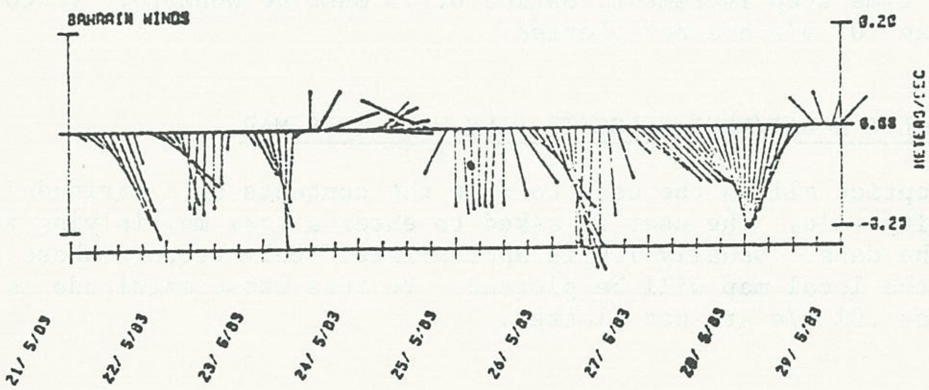
This option allows the user to plot a time dependent file. The user specifies the start and end times for the plot, the time step for calculating entries, the spacing of minor tic marks, major tic marks, how often to annotate the hours, and how often to annotate the date.

The routine calculates the U and V velocity components. If the V component is always zero, it is assumed that the file is an amplitude file, and a line plot will be done. If there are non-zero V components, then vectors are plotted with origin on the time axis. If a stick (or vector) plot is desired for an amplitude file, the user should rotate U components with a multiplicative factor so they appear to be V components instead.

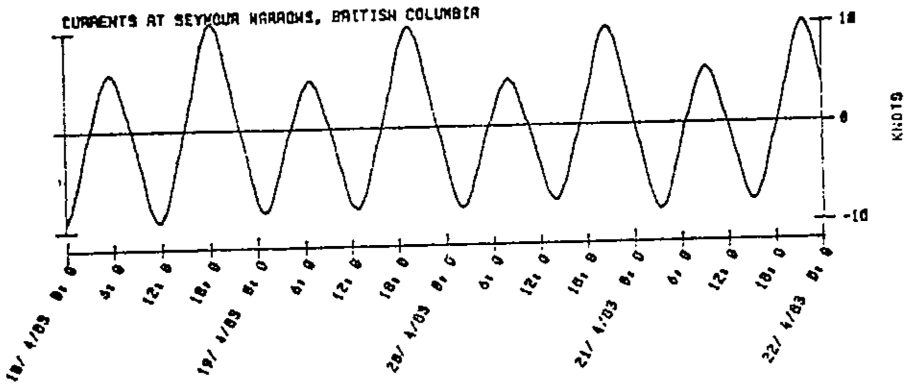
Additionally, the user can scale the data, select the length of the plot, annotate the scale label, and annotate the plot with a title. Usually it will be appropriate to scale the vectors with the maximum vector value, suitably rounded to one or two significant digits. Eight inches is usually an appropriate length for the plot if it is being plotted on a terminal. A longer length can be more suitable if the appropriate hardware is available.

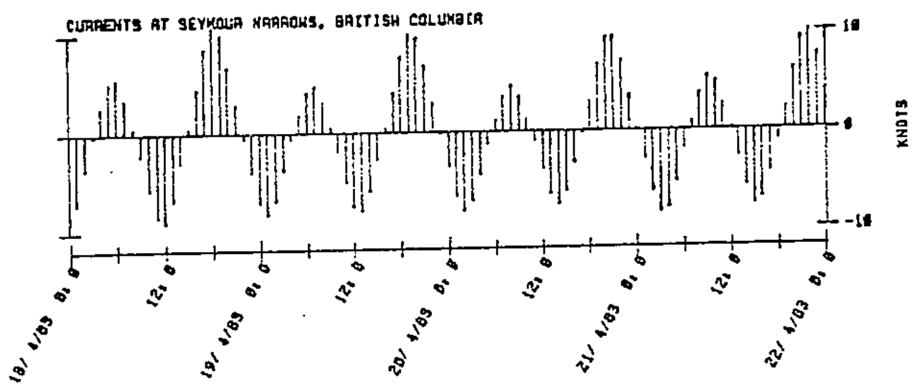
Figure 11a, b, and c, are respectively time dependent plots of wind data, tidal velocity as a line plot, and tidal velocity as a stick plot(the multiplicative factor was set to SQRT (-1.0) to rotate the components to yield a stick plot).

Figure 14.   Three percent of the wind for Bahrain.



Figures 15a & b.   Time dependent plot of tidal velocity as a line plot and as a stick plot.





0.10.35 DRAW VELOCITY ARROW SCALE FOR GRID VECTOR PLOTS

The velocity arrow scale is variable. The user is asked to enter the length of the velocity vector scale in centimeters/second. One hundred centimeters will yield an arrow one inch long. The user then enters a ten character label for the scale. Data from grid files is always scaled so that a one inch grid vector is assumed to be equal to 100 centimeters/second.

This option in effect allows the user to scale the grid vector plots as desired. For example, a grid vector area could be multiplied by two (doubling the size of its vectors) and in this option, the user could enter 100 centimeters/sec and label it "50 CM/SEC" or "0.5 M/SEC"

DAC AND SAC PLOTS

This set of options (0.10.41 to 0.10.52) use a work area in common with the rest of the system. Exiting from the Calcomp plotting overlay causes the data read by options 0.10.41, 0.10.42, and 0.10.43 to be blanked. The appropriate control flags are reset, and the data must be reread if it is to be used again.

0.10.41 GET VERTEX AND BOUNDARY DATA

This option reads the vertices for numerical finite element models from a VERDAT file (see DAC/SAC documentation).

0.10.42 GET TRIANGLE DATA

This option reads the triangle data from a TOPDAT file (see DAC/SAC documentation).

0.10.43 GET STREAMFUNCTION DATA

This option reads data from a streamfunction (STREAM) or diagnostic model file (DMVAL) (see DAC/SAC for documentation).

0.10.44 PLOT VERTICES

This option plots the vertices from a VERDAT file on a local map.

0.10.45 PLOT BOUNDARIES

This option draws the continuous boundary segments from a VERDAT file on a local map.

0.10.46 PLOT TRIANGLES

This option draws the triangles using the data from VERDAT and TOPDAT files on the local map.

0.10.47 LABEL VERTICES

This option annotates the vertices, offsetting the numbers to the left of the vertex by .030 inch.

0.10.48 LABEL TRIANGLES

This option annotates the center of every triangle with its number.

0.10.49 DRAW DEPTH CONTOURS

This option draws the depth contours using the data from VERDAT and TOPDAT files. The user can use the preset levels for the contours which are 20, 40, 60, 80, 100, 200, 300, 400, 500, 1000, 1500, and 2000 units, or the user can specify the levels to contour. Up to 20 contour levels can be specified. If more levels are desired, the routine can be used repeatedly with different levels specified.

0.10.50 LABEL DEPTHS

The vertices are annotated with the depths. The annotation is offset the height of the characters above the vertex point so there is not an overlap with the vertex labels (Option 0.10.47).

0.10.51 DRAW SAC/DAC CONTOURS

This option allows the user to contour the streamfunction values and/or amplitude factors and also contour any of the four diagnostic hinge modes. The contour levels are preset to eleven equally spaced levels between the maximum and minimum of the data. If these are not acceptable to the user, the user may specify different levels. This is done by entering the smallest contour level, the increment between levels, and the number of contours (20 maximum).

0.10.52 LABEL SAC/DAC VALUES

This option allows the user to annotate the vertices with the streamfunction or amplitude factors, or any of the four diagnostic hinge mode values. The annotation is written below the vertex, offset by the height of the characters. The number of decimal points to use is automatically controlled by the largest absolute value of the data.

MISCELLANEOUS

0.10.60 CALCOMP ENLARGE/SHRINK PLOT

This option enlarges or shrinks the plot. Only the very last call to this option counts.

0.11 LIST/PLOT DATA SITES

The list/plot data sites overlay enables the user to list and plot the data sites for data acquired pertaining to a spill of a hazardous substance or a pollutant. The data file structure is given in the Data File Formats. These options are primarily designed to give a fast look at the data sites, and to avoid tedious hand plotting of the information.

The sequence path response codes and their associated sections are as follows:

0.11.0 LIST/PLOT DATA SITES

- 1 SELECT SPILL-ACQUIRED DATA FILE
- 2 LIST DATA FILE
- 3 LIST AND PLOT DATA SITES

- 99 EXIT LIST/PLOT DATA SITES ROUTINES

0.11.1 SELECT SPILL-ACQUIRED DATA FILE

This option allows the user to specify which spill-acquired data file will be used in subsequent options. Additionally, the user specifies what time span will be selected for either listing or plotting. The routine verifies that the file exists. Options 0.11.2 and 0.11.3 will be automatically bypassed if a valid spill-acquired data file has not been specified.

0.11.2 LIST DATA FILE

This option prints out a formatted list of the spill-acquired data file specified in Option 0.11.1.

0.11.3 LIST AND PLOT DATA SITES

This option assigns a unique two character identifier to each data item. Data items that have overlapping locations on the OSSM map (in the same grid location) are given the same code. The spill-acquired data file is printed in a formatted list along with the two character code for each item. The user is asked to enter the name of the OSSM map on which the plotting will be done. The OSSM map is printed with the two character codes placed in the appropriate location. The user can cross-reference the map and the listing using the two digit codes. The boundaries of the OSSM map determine what data will be spatially selected. Data off the map is ignored.

0.11.99 END LIST/PLOT DATA SITES ROUTINES

Return to Main Option.

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APPENDIX A: SEQUENCE PATH RESPONSE CODES AND OPTIONS.

0.0 MAIN OPTION?

1 INITIALIZE MAP(S)
2 INITIALIZE LAGRANGIAN ELEMENTS
3 INITIALIZE WINDS/CURRENTS/SURFACE ELEVATIONS
4 INITIALIZE SPREADING/DIFFUSION
5 INITIALIZE STATISTICAL WINDS
6 INITIALIZE USER ROUTINES
7 TRAJECTORY RUNS AND CONCENTRATION MAPS
8 LIST/READ/SAVE INITIALIZATION
9 LOCATE GEOGRAPHICAL POSITIONS
10 CALCOMP PLOTTING
11 LIST/PLOT DATA SITES

999 END OF JOB.

0.1.0 INITIALIZE MAP(S)

1 LOAD MAP FILE AND OPTIONAL SHORELINE DESCRIPTORS
2 DELETE A MAP FILE AND ITS LINKED DATA BASES
3 SET MAP FILE PRIORITY (L, M, H)
4 DESIGNATE/CANCEL MAP PRINTED DURING SUMMARIES
5 CROSS LOAD MAPS AND SHORELINE DESCRIPTORS
6 SET LAT/LONG LINES FOR PRINTER MAPS
7 DUMP MAP TO DISK
8 PRINT MAPS

89 SUMMARIZE ALL MAP PARAMETERS

99 END INITIALIZE MAP OPTION

0.2.0 INITIALIZE LAGRANGIAN ELEMENTS

1 CLEAR LAGRANGIAN ELEMENTS
2 INITIALIZE LINE OR POINT SOURCE
3 INITIALIZE CIRCULAR DISTRIBUTION RANDOMLY
4 INITIALIZE BY OSSM COORDINATES
5 INITIALIZE FROM DISK FILE
6 WRITE TO DISK FILE
7 LIST A RANGE OF LAGRANGIAN ELEMENTS
8 RESTORE DEFAULT EVAPORATION AND WEATHERING PARAMETERS

89 SUMMARY OF LAGRANGIAN ELEMENTS

99 END INITIALIZE LAGRANGIAN ELEMENTS OPTION

0.3.0 INITIALIZE WINDS/CURRENTS/SURFACE ELEVATIONS

1 CREATE GRID AREA NAMES, KEY TO MAP
2 GET/LOAD STREAMFUNCTION GRID
3 GET LAT-LONG/VELOCITY FILE--LOAD GRID
4 SMOOTH GRID
5 ZERO GRID OVER LAND AND SHORELINES
6 PLOT GRID
7 SPECIFY LOCATION TO EVALUATE GRID FOR SUMMARY
8 SET MULTIPLICATIVE/ADDITIVE FACTOR FOR GRID AREA
9 DUMP A GRID TO DISK
10 AVERAGE NON-ZERO INTERSECTION OF TWO GRIDS TOGETHER
11 FIT MEASURED CURRENTS WITH GRIDS (LEAST-SQUARES)
12 DELETE GRID AREA

21 CREATE TIME FILE AREA NAMES
22 GET/LOAD TIME FILE
23 PLOT TIME FILE
24 SET MULTIPLICATIVE/ADDITIVE FACTOR FOR TIME FILE AREA
25 DUMP A TIME FILE AREA TO DISK
26 TAKE TIME DERIVATIVE OF TIME FILE AREA
27 CORRECT TIDAL COEFFICIENTS FOR TIME AND AMPLITUDE
28 DELETE TIME FILE AREA

40 JOIN/DISJOIN MAP TO TIME FILE AREA
41 JOIN/DISJOIN GRID AREA TO TIME FILE AREA

89 SUMMARIZE ALL ACTIVE INITIALIZATIONS

99 END WINDS/CURRENTS/SURFACE ELEVATIONS INITIALIZATION

0.4.0 INITIALIZE DIFFUSION AND SPREADING OPTIONS

1 DIFFUSION SIMULATED BY RANDOM WALK

99 END DIFFUSION AND SPREADING INITIALIZATION

0.5.0 INITIALIZE STATISTICAL WINDS

1 INITIALIZE STATISTICAL WIND FOR HISTOGRAMS
2 LOAD A WIND HISTOGRAM
3 DELETE A WIND HISTOGRAM
4 SPECIFY VALID MONTHS FOR WIND HISTOGRAMS
5 SAMPLE STATISTICS FOR WIND HISTOGRAMS
6 SET MULTIPLICATIVE FACTOR AND DURATION
7 TURN STATISTICAL WINDS ON/OFF

99 END STATISTICAL WINDS INITIALIZATION

0.6.0 INITIALIZE USER ROUTINES

99 END USER ROUTINES INITIALIZATION

0.7.0 TRAJECTORY RUNS AND CONCENTRATION MAPS

1 RUN WITH SET PARAMETERS
2 RESET ZERO HOUR
3 RESET CURRENT MODEL TIME
4 AUTOMATIC INCREMENT TO START AND END TIMES
5 SET START TIME, END TIME, TIME STEP INCREMENT
6 SET TIME OF NEXT MAP, TIME STEP BETWEEN MAPS
7 PRINT A SUMMARY WITH EACH MAP
8 DUPLICATE LISTING ON TAPE6
9 SUPPRESS MAPS AND SUMMARIES BEING PRINTED AT TERMINAL DURING RUNNING
10 MAPS BY POLLUTANT TYPE OPTIONS
11 RECEPTOR MODE MAPPINGS

0.7.11 RECEPTOR MODE MAPPINGS

1 TIME CONTOURS
2 PROBABILITY DISTRIBUTION

99 EXIT RECEPTOR MODE MAPPINGS ROUTINES

89 SUMMARIZE RUN OPTIONS

99 EXIT TRAJECTORY RUNS AND CONCENTRATION MAPS ROUTINES

0.8.0 LIST/READ/SAVE INITIALIZATION

<u>LIST</u> LIST ALL INITIALIZED PARAMETERS
<u>READ</u> READ INITIALIZATION FILE FROM DISK (NEW FORMAT SEPT, 82)
<u>SAVE</u> SAVE INITIALIZATION FILE ONTO DISK (NEW FORMAT SEPT,82)

<u>99</u> EXIT LIST/READ/SAVE INITIALIZATION ROUTINES

0.9.0 LOCATE GEOGRAPHICAL POSITIONS

1 ENTER LATITUDE, LONGITUDE
2 ENTER MAP NAME, I, J

99 EXIT LOCATE GEOGRAPHICAL POSITIONS ROUTINES

0.10.0 CALCOMP PLOTTING

STANDARD TASKS

1 OPEN PLOT FILE
2 GLOBAL BOUNDARIES DESIRED
3 CLOSE PLOT FILE
4 GET A PARTICULAR MAP FOR PLOTTING
5 STANDARDIZED TRAJECTORY PLOT
99 EXIT CALCOMP PLOTTING ROUTINES

LAND MAP AND TRAJECTORIES

11 DRAW GLOBAL BOX
12 DRAW LOCAL BOX
13 DRAW COASTAL OUTLINES
14 HASH FILL NON-WATER AREAS
15 PLOT SHORELINE DESCRIPTORS
16 PLOT TRAJECTORIES
17 ADVANCE TO NEW PLOT SURFACE

ANNOTATE

21 STANDARD ANNOTATION FOR TRAJECTORIES
22 ANNOTATE TOP THREE LINES
23 ANNOTATE BOTTOM THREE LINES
24 DRAW SCALE AND ANNOTATE
25 DRAW LAT/LONG LINES AT INCREMENTS OF D1, ANNOTATE AT INCREMENTS OF D2
26 ANNOTATE LAT/LONG CORNERS OF PLOT
27 ANNOTATE SHORELINE DESCRIPTORS (LEGEND)

VELOCITY VECTORS

31 PLOT GRID AREA VECTORS FOR THIS MAP
32 PLOT SUM OF ALL VECTORS FOR THIS MAP
33 PLOT A LAT/LONG-VELOCITY FILE WITH THIS MAP
34 PLOT A TIME-DEPENDENT FILE (AMPLITUDE OR VECTOR)
35 DRAW VELOCITY ARROW SCALE FOR GRID VECTOR PLOTS

DAC AND SAC PLOTS

41 GET VERTEX AND BOUNDARY DATA
42 GET TRIANGLE DATA
43 GET STREAMFUNCTION DATA
44 PLOT VERTICES
45 PLOT BOUNDARIES
46 PLOT TRIANGLES
47 LABLE VERTICES
48 LABLE TRIANGLES
49 DRAW DEPTH CONTOURS
50 LABLE DEPTHS
51 DRAW SAC/DAC CONTOURS
52 LABLE SAC/DAC VALUES

MISCELLANEOUS

60 CALCOMP ENLARGE/SHRINK PLOT

99 EXIT CALCOMP PLOTTING ROUTINES

0.11.0 LIST/PLOT DATA SITES

1 SELECT SPILL-ACQUIRED-DATA FILE
2 LIST DATA FILE
3 LIST AND PLOT DATA SITES

99 EXIT LIST/PLOT DATA SITES ROUTINES

0.999.0 END OF JOB

APPENDIX B. QUESTIONNAIRE

This concludes the OSSM manual. All users are requested to fill in the enclosed questionnaire and return it. Thank you.

User's name: ____________________

User's address: ____________________

Please list by option the sections of the documentation that you consider vague, misleading, or difficult to understand:

OPTION COMMENT

(Attach additional sheets as necessary.)

Please list by option or subroutine any defects in routines that you have discovered.

OPTION OR SUBROUTINE DESCRIPTION

(Attach additional sheets as necessary.)

Additional routines you would like to see included:

(Attach additional sheets as necessary.)

Routines you would like to see changed:

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(Attach additional sheets as necessary.)

Additional routines you have added:

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(Attach additional sheets as necessary.)

Would you like to be on a list of users to receive periodic updates of documentation? /_/ YES /_/ NO

Please return to

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